SCIENCE ABSTRACTS.

Section A.—PHYSICS.

JANUARY 1924.

GENERAL PHYSICS.

1. *The Uses of Logarithmic Paper.* **P. Schreiber.** (Zeits. Vereines deutsch. Ing. 67. pp. 930–932, Sept. 22, 1923.)—The author describes a graphical method of evaluating a function, such as $a^{\alpha}b^{\beta}c^{\gamma}d^{\delta}e^{\epsilon}$ . . ., by using logarithmic paper. Instances of the application of the method are given. W. H. S.

2. *Glass-to-Metal Joint.* **M. L. Dundon.** (Am. Chem. Soc., J. 45. pp. 716–717, March, 1923.)—Describes the making of a joint between ordinary soft glass and copper tubing. The method given by McKelvy and Taylor [Abstract 2 (1921)] was unsuccessful with soft glass tubing 8 mm. in diameter owing to strains in the glass produced by heating. In the process described by the author the end of the glass tube is drawn to fit easily into the copper tube for about 1 cm. It is then platinised, heavily copper-plated and polished. After fitting in the copper tube, copper is deposited on both tubes across the joint until they are completely united by a solid mass of deposited copper. A similar joint may be made between copper-plated steel tubing and soft glass. T. H.

3. *Disturbance of Pendular Systems by a Horizontal Acceleration.* **M. Schuler.** (Phys. Zeits. 24. pp. 344–350, Aug. 15, 1923.)—It is only pendular systems with a period of 84 minutes—the same as that of a simple pendulum of length equal to the earth's radius—that are unaffected by a horizontal acceleration. Following up this clue leads direct to the equations for the gyrostatic compass. A. D.

4. *The Stroud System of Teaching Dynamics.* **J. B. Henderson.** (Engineering, 116. pp. 409–410, Sept. 28, 1923.)—Paper read before the British Assoc., Liverpool, 1923.

5. *Effect of Rotation upon the Sensitiveness of Absolute Pressure Measurements.* **A. Michels.** (Ann. d. Physik, 72. 4. pp. 285–320, Aug. 21, 1923.)—The method most commonly adopted for the measurements of high pressure, is to balance the thrust on a piston (frequently a differential piston) by applying known weights. There is much friction between the piston and cylinder, and to diminish the effects of this, tapping the piston, and rotating it, have been tried with success. The author applies the results of Sommerfeld's treatment of friction in lubricated journal bearings. In the case considered, the axis is vertical, and the weight of the piston plays no part. The conclusions arrived at are that the central position is unstable, when the piston is being rotated, and that the eccentricity gradually increases as the speed diminishes, to a point where solid friction enters. Before solid friction enters, the retarding torque should be directly proportional to the angular velocity. By means of experiments, both of these conclusions are verified. According to the theory, we should have

$$A = \frac{1}{t}\log_e \frac{n-\nu}{n} = \text{constant},$$

where n is the total number of revolutions made, ν the number completed at time t. Owing to the entry of solid friction, n is not the total number of revolutions *actually* made, but it is found possible to obtain a value of n, by trial and error, which does make A constant (to within 1 %) over most of the motion, after which it falls rapidly. The critical velocities, corresponding to the entry of solid friction, also agree among themselves.

A further series of experiments is described, undertaken to show with certainty that solid friction does eventually occur. The insulation resistance of the film of oil is measured, photographic records of the swings of the galvanometer needle being obtained. These show the resistance at starting in the neighbourhood of 500 ohms, oscillating violently, and then settling down to 0·2 ohm. The oil film has gone.

W. G. B.

6. *The Reaction of the Air to a Circular Disc Vibrating about a Diameter.* **E. T. Hanson.** (Phil. Mag. 46. pp. 434–441, Sept., 1923.)—Expressions are found for the reaction of the air to a circular disc vibrating about a diameter in a circular hole in an infinite plane wall. The edge effects are neglected, as in the similar investigation by Rayleigh, for normal vibration. The paper is mainly mathematical. The effect is found to be an increase in the effective moment of inertia of the disc, by an amount equal to $1/\pi$ of the moment of inertia of a hemisphere of air of the same radius as the disc, when the radius is small compared with the wave-length of the waves sent off. There is also a very small damping due to the energy propagated in these waves.

W. G. B.

7. *Linear, Exponential, and Combined Dampings.* **E. H. Barton** and **H. M. Browning.** (Phil. Mag. 46. pp. 399–406, Sept., 1923.)—Recent papers by H. S. Rowell have called attention to the fact that the effects of solid friction (constant) and viscous friction (varying as the speed) in damping vibrations are quite distinct. [Abstracts 263 and 625 (1923)]. In the former case successive swings are in A. P., while in the second they are in G. P. In the present paper this is examined experimentally. The vibrator is a lath with (in some experiments) a heavy bob, and the two forms of damping are produced by rubbers of cork, plain or lubricated with graphite or vaseline, rubbing on the lath

and cards attached to the lath, respectively. Traces are obtained by salt flowing from a funnel and caught on a moving board, as in previous work. Numerous photographs of these are given, and it is seen that when solid friction predominates, the damping is "linear," but that in the other case the damping is more nearly exponential. W. G. B.

8. *Movement of a Rotating Shaft Poised on Two Cushions.* **C. Melli.** (N. Cimento, 35. pp. 77–85, Jan.–Feb., 1923.)—Dynamical treatment of this problem, usually dealt with as one in relative equilibrium.

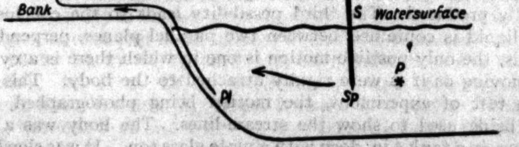
A. D.

9. *Helicoidal Molecular Pump.* **Holweck.** (Comptes Rendus, 177. pp. 43–46, July 2, 1923. Onde Élec. 2. pp. 497-503, Sept., 1923.)—The principle of the instrument is the same as that of the molecular pump of Gaede [see Abstract 1763 (1913)]. In the interior of the cylindrical pump body are cut two helical grooves of depth increasing towards the middle where they connect with a common aspirator tube. Inside the pump-body with a clearance of only 0·03 mm., a smooth drum is rotated on enclosed ball-bearings by means of a two-phase asynchronous motor, of which the rotor is inside a thin metal container fixed in such a manner that the rotation of the drum can take place without communication with the external atmosphere. The smaller ends of the helical grooves connect with a preparatory pump. The normal speed of rotation is 4500 r.p.m. The constants of three types of pump under varying conditions of preparatory vacuum, with and without the assistance of liquid air, are enumerated.

A. B. C. L.

10. *Flow of Gas through a Jet.* **B. L. Montel** and **E. Foà.** (Accad. Sci. Torino, Atti, 57. 14a. pp. 277–292, 1921–1922.)—A simple method of estimating the volume v passed, by blowing the jet upwards against the midpoint of a wide flat balance-pan; then the upward thrust is equal to $\rho v^2/ag$ within ½ per cent., where a is the area of the nozzle. Discussion of corrections and amounts of error. A. D.

11. *The Mass-Movement of Water in Explosions under Water.* **C. Ramsauer.** (Ann. d. Physik, 72. 4. pp. 265–284, Aug. 21, 1923.)—In an explosion under water two phenomena are worthy of notice, *i.e.* the spreading of a wave of compression in the water, and the volume expansion of the mass of gas generated by the explosive material. The author seeks to determine experimentally and theoretically the spreading and the velocity of the mass-movement of the water. As the employment



of any mechanical form of sounder is inadvisable, owing to slowness of action and want of mechanical strength, an electrical sounder or detector was used, a diagram of which is given. Here M is an electromagnet, S a steel bar, Pl a metal plate, B a battery, P the explosive, and Sp a spring holding an armature. Normally the current flows and the armature is held on to the electromagnet. When an explosion takes place the current will be broken if the volume of gas generated by the explosion reaches beyond the end of the longitudinally insulated steel rod S. Details of the apparatus follow, together with precautions to be taken, and sources of error to be expected. A table of results is given, showing the amount of charge and the depth, and from the results an empirical formula is derived $r_{\text{max.}} = 159 \cdot 3\sqrt[3]{M/P}$ cms. Here M is the mass of explosive, P the total pressure due to air and water, and r the amount of water movement. The differences between the observed and calculated values are of the order 1 to 2 per cent. By measuring the time between the interruption of the current at two sounders, the velocity of the water movement can be calculated, the distance apart of the sounders being known.

The remainder of the paper consists of an elementary theoretical discussion of the problem; the author comparing the under-water explosion to the motion of a heavy piston suddenly released in a cylinder containing a compressed gas. If E_x is the work done by the expanding gas when the piston has reached a position x, A_x the work done by, and L_x the kinetic energy of the piston, then $E_x = \int_{V_0}^{V_x} P_x dV_x$, $A_x = P_a(V_x - V_0)$ and $L_x = MC_x^2/2$. Also $E_x = A_x + L_x$. Curves are drawn of these quantities for the ideal case, and these are compared with the actual experimental results. Good general agreement is found. T. B.

12. *Experiments on the Motion of Solid Bodies in Rotating Fluids.* **G. I. Taylor.** (Roy. Soc., Proc. 104. pp. 213–218, Sept. 1, 1923.)—Some years ago Proudman pointed out that all slow, steady motions of a rotating liquid must be two-dimensional. If a three-dimensional body is slowly moved in a rotating fluid, there are three possibilities. The motion of the liquid may never become steady; the motion may be steady, but not small near the body; the motion may be steady and two-dimensional. The first seems unlikely. The second has more chance of being true, and in a previous paper [Abstract 261 (1923)], where the steady motion of a sphere along the axis of a rotating fluid was examined mathematically, a solution was obtained which did not decrease as the velocity of the sphere decreased. But it is unlikely that such a motion can be experimentally produced. The third possibility leads to the conclusion that if the liquid is contained between two parallel planes, perpendicular to the axis, the only possible motion is one in which there is a cylinder of fluid moving as if it were rigidly attached to the body. This was put to the test of experiment, the motion being photographed, coloured liquid being used to show the stream-lines. The body was a cylinder 1 in. long, in a tank 4 in. deep with a plate glass top. It was slowly moved along the bottom, and it was found that, introducing a stream of colour 1 in. in front of the imaginary cylinder which is the continuation of the body, and $1\frac{1}{2}$ in. above it, the stream divided and passed round the imaginary cylinder as if it had been solid. By introducing the colour within the imaginary cylinder, where it stayed, it was further proved that the third of the three possibilities, unlikely as it seemed, was certainly the true one in this case. The photographs are reproduced.

W. G. B.

13. *Types of Crystal Symmetry in which no Finite Symmetrical Crystal Unit, having the Complete Symmetry of the Crystal, is to be Found.* **W. Barlow.** (Phil. Mag. 46. pp. 638–640, Oct., 1923.)—The author raises the question whether there is evidence of the universal presence of units of any nature, space units or other, which epitomise the crystal symmetry, and concludes that there is no geometrical necessity for the presence of such a representative symmetrical unit, the crystal symmetry being completely developed by the characteristic symmetrical operations of the type of crystal concerned as applied to an unsymmetrical unit. If the unit has a symmetry, which is the epitome of the crystal symmetry, a large proportion of the 230 types of crystal will owe their symmetry entirely to the form of the unit, and not even partially to the relative situation of two or more units; this applies to all types in which any one of the minimum group of coincidence operations is a screw movement; nearly three-fourth of the types are affected. In the remaining types the existence of a composite finite group, formed of several units, is not precluded; the units may be either unsymmetrical, or possessed of a symmetry equal to, or greater than that presented by the crystalline mass. In the majority of cases the crystal structure owes its symmetry to the symmetrical disposition, and not to the symmetrical form of the units. While in organic nature other symmetries are observed than those belonging to the above types, *e.g.* a five-fold symmetry, no crystal presents a symmetry outside these types, such as one corresponding to the completely symmetrical pentagonal dodecahedron, this suggests that an arrangement developed by the characteristic operations is necessary for the formation of crystals.

H. N. A.

14. *X-Ray Investigation of Fatty Acids.* **A. Müller.** (Chem. Soc., J. 123. pp. 2043–2047, Aug., 1923.)—A series of fatty acids belonging to one class was investigated; and in confirmation of previous work by de Broglie, by Friedel, and by Piper, large spacings were found, increasing with the number of CH_2-groups. Each acid was melted on a glass plate, and spread out into a layer 0·1 to 0·2 mm. thick; they all crystallised in flakes parallel to the glass surface, and gave extremely good reflections, with well-defined lines. The flakes, being oriented parallel to the plane surface of the glass, acted as a single crystal. The substance was oscillated 10° on either side of the X-ray beam. The main set of planes, indicated by a series of well-defined lines in each acid, corresponded to a spacing d_1 which varied regularly as follows, as the number of carbon atoms increased; the first figure in each pair is the number of C atoms, the second the value of d: 10, 23·2; 12, 27·0; 14, 32·2; 16, 34·7 (palmitic acid); 18, 38·7 (stearic acid); 22, 47·8. Of the other two spacings, indicated by two rather broad lines, the first, d_2, varied between 4·05 and 4·11, and the second, d_3, between 3·62 and 3·68; so that they are nearly the same for all six acids. If the angles between the planes which constitute the cell are assumed to be right angles, the number of molecules per cell is found to be very nearly 1·0; but the length of the chain, obtained by piling all the carbons and oxygens one on top of the other in a straight line, is something like 30 Å., as against 38·7 Å. observed; so that a more detailed investigation is required. An experiment with an acid of the unsaturated type showed a much larger value of d_1 for the same number of C atoms, d_2 and d_3 were the same as before. Adam has measured the length of these long chains in fatty acids, by determining the area and density of unimolecular films; his results are of the same order as those given above, though somewhat smaller; the length of the chain increasing with the increase of CH_2-groups. Becker and Jahnke found a similar increase for lithium salts of acids with odd numbers of carbon atoms; the values they obtained for d, are in almost complete disagreement with those obtained by the author, except for lauric acid; the method they used is not considered very suitable. H. N. A.

15. *The Crystalline Structure of Anhydrous Racemic Acid.* **W. T. Astbury.** (Roy. Soc., Proc. 104. pp. 219–235, Sept. 1, 1923.)—After a large number of crystallisations a few small untwinned crystals were obtained; the reflection from (010) is enormous; $d_{010} = 4\cdot50$ Å.U., $d_{001} = 4\cdot17$ Å.U.; he crystals belong to the triclinic pinakoidal (anorthic) class of symmetry, *i.e.* they possess centro-symmetry only, and we might expect at least one right-handed and one left-handed molecule per cell; calculation from the above spacings, however, combined with Groth's values for the angles α, β, and γ, show that there is only one molecule in this cell. The results of the complete X-ray examination of the crystal show that the reflections are all in agreement with one molecule per cell with the exception of planes (110), (310), (130), $(1\bar{1}0)$, $(1\bar{3}0)$, and $(\bar{1}1\bar{2})$; in these the observed spacing is double the calculated. Such anomalies are very simply explained if the molecules at the ends of each of the c edges of the cell are similar; the c edges adjacent to one having right-handed molecules at its ends will have left-handed molecules. All the R molecules are exactly alike, and so are all the L molecules, but the R's and L's are centro-symmetrical with respect to each other. Careful examination of the evidence does not afford any reason for believing racemic acid to be an inactive, double molecule of weight 300. It appears that the "habit" of the crystal has deceived the crystallographer, and led him to choose a cell which is not fundamental, in the sense of being the minimum parallelopiped that will repeat through space. The crystallographic cell contains two half molecules, but the fundamental cell is built of one right-handed and one left-handed molecule. The author concludes that the molecule is of about the same shape and dimensions as that of tartaric acid, but a little shorter. An explanation is given of the multiple twinning and irregular growth of anhydrous racemic acid. H. N. A.

16. *Crystal Structure of Potassium Hydrogen Fluoride.* **R. M. Bozorth.** (Am. Chem. Soc., J. 45. pp. 2128–2132, Sept., 1923.)—The positions of the potassium and fluorine atoms in tetragonal potassium hydrogen fluoride, KHF_2, have been determined by means of X-rays. The dimensions of the unit are $5\cdot67 \times 5\cdot67 \times 6\cdot81$ Å. The structure may be described as an ammonium chloride arrangement of potassium atoms, and fluorine dumb-bells, the two atoms of each dumb-bell lying in a plane perpendicular to the tetragonal axis. For the hydrogen atoms there are two possible positions, one of which is in the middle of the dumb-bell, forming an HF_2-ion. AUTHOR.

17. *The Crystalline Structure of Silver Iodide.* **R. B. Wilsey.** (Eastman Kodak Co.'s Research Lab., Comm. No. 184. Phil. Mag. 46. pp. 487–

496, Sept., 1923.)—Using the powder method the author has previously found that silver iodide gave the diffraction pattern of the diamond, cubic, or zinc sulphide type of crystal [Abstract 1971 (1921)]. Davey has found the same structure, but Aminoff questions this, and states that, within the usual limits of error, the powder method gives the same lines with either the hexagonal or the diamond type. Using Laue diagrams he concludes that AgI crystals are hexagonal. Wyckoff accepts this conclusion, and includes this case in his list of " known failures to assign correct crystal structures " by using the powder method alone. A calculation of all the lines to be expected from the two structures concerned shows that, while they have many lines in common, each has lines not possessed by the other, the hexagonal structure having much the greater number of lines. Considerable variation was found in the powder photographs of AgI taken in the present investigation. A few samples showed only the lines of the diamond cubic structure, which included two lines which cannot be accounted for by the hexagonal structure; the other samples prepared varied, from those showing one or two faint lines characteristic of the hexagonal structure, to samples giving as many as ten such lines, in addition to the seven lines common to both structures. All the photographs showing predominantly hexagonal structures contained one line which was most accurately accounted for by the cubic structure, differing from the nearest theoretical hexagonal lines by amounts greater than the experimental error. The conclusion is that both forms exist, most of the samples showing a mixture, in which the hexagonal form predominates. Discrepancies in previous results seem to be due to differences in the samples used. In recording the diffraction lines a **U**-shaped piece of lead, with its opening directed towards the anti-cathode, was placed at the centre of the photographic film, to protect it from the primary X-ray beam during the greater part of the exposure, thus preventing fogging of the film. To avoid error due to shrinkage of the film during development, notches were cut 10° apart in the semicircular cassette holding the film, and these were printed on the film by the general scattered radiation, and gave fixed points from which measurements could be taken. H. N. A.

18. *Röntgenographic Determination of the Structure of Rolled Metal Foil. Part II.* **H. Mark** and **K. Weissenberg.** (Zeits. f. Physik, 16. 4. pp. 314–318, 1923.)—In Part I [see Abstract 1869 (1923)] it was shown that in rolled foil of Cu, Ag, Au, Al, and Pt, the crystallites were orientated by the working into a definite order, characterised by a related group of lattice positions in which the direction [112] is parallel to the direction of rolling, [111] is parallel to the transverse direction, and [110] is parallel to the foil normal. The group is formed by a distribution about these positions. The present paper investigates the subject in greater detail, since variations occur due to the material and method of rolling. With Ag, Au, and Pt, the distribution is almost symmetrical, and an exact determination shows a deviation of about 3°. With Al and Cu the deviation attains 8°. It has now been found that two non-related groups of lattice positions exist of which the first is characterised by a [112] direction parallel to the direction of rolling and a <110> plane parallel to the rolling plane; the second by a [100] direction and a <100> plane. With Au and Pt these two sets of crystallite positions occur in about equal amount, but with Ag, Cu, and Al the former distribution prevails. H. H. Ho.

19. *Theory of the Born-Lertes Effect.* **H. Schmick.** (Phys. Zeits. 24. pp. 291–294, July 15, 1923.)—From Debye's two-pole theory [Abstract 571 (1912)] Born concluded [Abstract 1029 (1920)] that a rotatory electrostatic field of high frequency must exercise a measurable turning moment on a two-pole fluid. P. Lertes (Zeits. f. Physik, 6. p. 56, 1921), verified this deduction independently of a similar effect obtained at low frequencies and attributable to the conductivity of the fluid. Bergholm [Abstract 843 (1922)] thinks anisotropic relations of the displacement electrons sufficient to account for the observed effects. The present paper discusses this question mathematically, with adverse results. A. D.

20. *Secondary Spectrum of Hydrogen.* **P. Das.** (Calcutta Math. Soc., Bull. 14. pp. 13–17, June, 1922.)—A model of the hydrogen molecule. Two nuclei, with an electron at their centre of gravity; the two nuclei describe closed orbits round this nucleus, and the other electron describes some orbit at a comparatively large distance from the complex structure. This leads to Rydberg's formula, to a large number of closely grouped lines, and to a close relation between the secondary spectrum and the Balmer lines; and bears out in a striking manner the conjecture of Foote and Mohler that the resonance- and ionisation-potentials determined by electron collision are not really those of the atom but of the molecule. A. D.

21. *The Effective Function in Weyl's Physics. Part III.* **R. Weitzenböck.** (Akad. Wiss. Wien, Ber. 130. 2a. Nos. 1 and 2. pp. 15–23, 1921.)—In this paper, which is entirely mathematical, the author investigates the connection between the 6 invariants previously derived by him and enumerated by Weyl. Reference is made to recent work by Pauli and Bach [see Abstract 40 (1922)]. It is shown that no generalisation occurs when the second differentials $\partial^2\phi_i/\partial x_\alpha \partial x_\beta$ of the components ϕ_i of the electromagnetic potentials are considered as condition quantities, the same 6 effective functions being obtained even when a new test invariant tensor of the third degree is introduced. H. H. Ho.

22. *Special Energy Values in Mechanical Systems.*—**A. Klose.** (Ann. d. Physik, 72. 1. pp. 67–80, July 20, 1922.)—Remarking upon the fruitful application by Bohr of the quantum idea, the author points out that there are purely mechanical systems in which special energy values are privileged. The periodic orbits in the restricted problem of the three bodies are instanced, and their stability is discussed. W. G. B.

23. *Rutherford's Neutrons.* **A. Pontremoli.** (Accad. Lincei, Atti, 32. i. pp. 277–280, March 18, 1923.)—Works out that one quantum will cause the brief emission of rays of a frequency 1849 times that of the spectrum of hydrogen. A. D.

24. *The Electric Field of a small, Heavy-charged Sphere surrounding a Centre of Gravitation.* **G. Mie.** (Ann. d. Phys. 70. 7. pp. 489–557, April 5, 1923.)

25. *Degenerate Systems in the Disturbed Motion Calculus.* **L. Nordheim.** (Zeits. f. Physik, 17. 4–5. pp. 316–330, 1923.)—The author refers to two developments of the disturbed motion calculus in special connection with the quantum theory for dealing with cases of degeneracy: (1) By Born in collaboration with Pauli and with Heisenberg, respectively

[Abstracts 1955 (1922) and 1316 (1923)]; (2) by Epstein, employing a method based on Delaunay's well-known treatment of lunar theory [Abstract 1886 (1922)]. The author here develops a method by which he has been able to deal with cases of degeneracy which had shown themselves intractable by either method. The problem which led thereto occurred in his investigations of the possible models of the H molecule according to quantum theory, which will be published shortly.

The starting point of all disturbed motion calculation is their representation in terms of the canonical conjugate angle and action variables $w_1^0 \ldots w_r^0$, $J_1^0 \ldots J_r^0$ (r being the number of degrees of freedom) of the undisturbed system with Hamilton function H_0, depending only on J_k^0, while the disturbed members are periodic in W_k^0. The solution is obtained by successive approximation in terms of a parameter λ, but is subject to the conditions of no degeneracy in the undisturbed system. Born and Heisenberg distinguished between two essentially different cases: (1) Degeneracy proper, in which $dW_r^0/dt = dH_0/\partial J_r^0 = 0$ for all values of J_r^0, *i.e.* H_0 is independent of J_r^0. In the undisturbed system there are then linear relations between the frequencies for all values of J_k. They have solved this case by Gauss' method of secular disturbances. (2) Accidental degeneracy, in which $\partial H_0/\partial J_r^0 \neq 0$, generally, but vanishes for certain definite values of J_k^0, *e.g.* in the many body problem in the case of commensurable planetary orbits. There will then be a linear relation between the exceptional values of J_k.

Bohlin and Poincaré have shown [Méthodes nouv. de la méchanique céleste, (1893)] that if the transformation function in the neighbourhood of such incommensurabilities be expanded in powers of $\lambda^{1/2}$ instead of λ, everything becomes determined. The author generalises the Born-Pauli scheme by combining it with Bohlin's method, and shows it to be the proper method for dealing with accidental degeneracy, being applicable even when this is of the manifold type.

The author develops further analysis devised for dealing with the previously mentioned difficulty arising in the case of the H_2 molecule, and which he calls critical degeneracy, in which some of the J_k assume critical values owing to the phase space becoming of lower order than the number of degrees of freedom, and the corresponding w_k become geometrically indeterminate. The method is one of periodic solutions. The relativistic motion of an electron about its nucleus is an example. Specified in terms of two pairs of W, J conductors, the square root of the semi-axis major and the mean anomaly on one side, and the moment of impulse and perihelion distance on the other, the orbit is geometrically an ellipse with perihelion motion. If transformed into a circle by the eccentricity vanishing, the plane space shrinks from 2 dimensions to 1, without the degeneration of either of the types considered above, since the critical values of the perihelion motion and of the mean anomaly remain incommensurable. G. W. DE T.

26. *Reply to Einstein's Remarks on "Contributions to the Cosmologic Problem."* **F. Selety.** (Ann. d. Physik, 72. 1. pp. 58–66, July 20, 1923.)—In reply to Einstein [see Abstract 825 (1923)] the author recapitulates and further explains his previous paper [see Abstract 40 (1923)]. E. F.

27. *The Fundamentals of the Quantum Theory and its Experimental Proof.* **R. Ladenburg.** (Zeits. techn. Physik, 4. 6. pp. 225–232, and

4. 7. pp. 249–257, 1923.)—A concise summary of the principles involved and the experiments on which the quantum theory rests. Mainly concerned with optical and X-ray spectroscopy. A. C. M.

28. *The Quantum, Atoms, and Radiation.* **O. Lodge.** (Beama, 13. pp. 10–19, July; 80–88, Aug.; 148–157, Sept., and pp. 211–220, Oct., 1923.)—A useful popular account of the theory of quanta in relation to the atom, in which the astronomical analogy is freely used. A. C. M.

29. *Propagation of Certain Types of Electro-Magnetic Waves.* **D. R. Hartree.** (Phil. Mag. 46. pp. 454–460, Sept., 1923.)—The disturbance in the less dense medium in the case of total reflection at the surface of separation of two transparent media is investigated. It is found to be a solution of Maxwell's equations, differing from the simplest type in three respects: (*a*) The amplitude is not constant over a wave front; (*b*) the wave is not purely transverse; (*c*) the phase-velocity is greater than the normal velocity of light in the medium. The results show that a certain concentration of energy in a small region of the wave front is compatible with Maxwell's equations, but, owing to the fact that the energy integrated over the wave front is not finite, the author does not consider that any light is thrown on the question of light quanta. A method is suggested for testing the theory experimentally. M. H. A. N.

30. *Spherically Symmetrical Solutions in the Einstein Gravitational Theory.* **W. Alexandrow.** (Ann. d. Physik, 72. 2. pp. 141–152, July 20, 1923.)—A general and exact investigation of spherically symmetrical solutions of the field equations in Einstein's original theory, *i.e.* solutions of the form

$$ds^2 = f^2dt^2 - 2qdt\,\Sigma(x_i\,dx_i) - \Sigma dx_i^2 - l(\Sigma x_i\,dx_i)^2 \quad \ldots\ldots \quad (1)$$

where the summations extend over x_1, x_2, and x_3, and f, q, and l are functions of t and $\sqrt{x_1^2 + x_2^2 + x_3^2}$ only. It is customary to eliminate the second term by a transformation of the form $t' = \theta(r, t)$, since any such transformation does not disturb the symmetrical form of ds^2. But when this has been done the principle of least action is no longer applicable and recourse must be had to Einstein's equations. The author prefers to treat the unrestricted form (1) by the least action principle, and, by means of extremely ingenious substitutions carried out before making the variations, arrives at the following general solution:

$$f^2 = u(\partial\theta/\partial t)^2,\ 1 + lr^2 = 1/u - u(\partial\theta/\partial r)^2,\ qr = -u\partial\theta/\partial t\,.\,\partial\theta/\partial r$$

where $u = 1 - 2m/r$, and θ is an arbitrary function of r and t. This gives Schwarzschild's solution on making the time substitution $t' = \theta(r, t)$, and is therefore essentially static.

In a previous paper [see Abstract 176 (1922)] the author arrived, by the Hertzian (approximate) method, at a spherically symmetrical solution which seemed to indicate the possibility of gravitational "vibrations" due to a single point source. This special solution is, however, found from that just given by setting $\theta = t + \epsilon H$ and neglecting powers of ϵ above the first. It is thus only approximate and the "optical" equations satisfied by H really express only the choice of a special coordinate system, namely, that in which the Schwarzschild solution holds good. M. H. A. N.

31. *Space and Time.* **E. Persico.** (Accad. Lincei, Atti, 32. i. pp. 524–527, May 20, 1923.)—A discussion, in terms of a non-Euclidean universe as applied to astronomical distances and of a Euclidean 4-dimensional universe as applied to terrestrial distances, as to the criteria of time and space considered separately. A. D.

32. *Relativity in Classical Physics.* **P. Straneo.** (Accad. Lincei, Atti, 32. i. pp. 221–225, March 4, 1923.)—It is generally stated, or assumed, that in order to take account of the theory of restricted relativity it is necessary to abandon the classical foundations and to adopt an Einsteinian starting-point. The author combats this, and contends that a complete examination of the problem shows otherwise. Assume the result of experience to be that the relative movement of the earth and the ether cannot be detected; the principle of contraction follows. If a uniform translatory movement leaves electromagnetic phenomena unchanged, we must (Lorentz and Poincaré) have

$$x' = k(x - vt), y' = y, z' = z, t' = k(t - (vx/c^2)), k = \left\{1 - (v/c)^2\right\}^{-1/2} \quad (1)$$

Assuming the law of composition of velocities to be

$$v = (v_1 + v_2)/\left\{1 + (v_1 v_2/c^2)\right\},$$

all the Lorentz transformations form a continuous group; and in order to transform the equations of any phenomenon into those for a system fixed relatively to the ether, all that is necessary to do is to use (1) instead of the corresponding Galilean expressions

$$x'' = x - vt, \ y'' = y, \ z'' = z, \ t'' = t \ \ldots\ldots\ldots\ldots \quad (2)$$

From (1) and (2) we have

$$x' = kx'', \ y' = y'', \ z' = z'', \ t' = k(t'' - (vx/c^2)) \ \ldots\ldots \quad (3)$$

But if (1) leave the phenomena unchanged and (2) correspond to a purely translatory movement without secondary effects, then (3) must cover the secondary effects accompanying translation. On Einstein's lines, (1) must correspond to a pure translation, and no secondary effects are necessary. Equations (3) are, however, capable of a single mechanical interpretation. The first of them is no other than the principle of contraction; and it is to be noted that Lorentz really worked on (3), not on (1). The fourth is apparently not intrinsic, since it is referred to a point on the fixed system, which point may be arbitrarily chosen. But we can eliminate x between (1) and the fourth equation of (3), and obtain

$$t' = k\left[t'' - \left(\frac{v}{c^2}\right) x'' + vt''\right] = \frac{1}{k} t'' - k \frac{v}{c^2} x'',$$

which depends only on constants and intrinsic quantities of the moving system. The first term in this shows that in consequence of the translatory movement there is a retarding effect of the second order; and the second shows that an observer at $x'' = 0$ would judge an event occurring at a point $x'' = x''$ as having occurred at a previous instant, the time-interval being proportional to the velocity. This latter is a preponderating effect, being of the first order. These two, together with the contraction, perfectly account, on ordinary classical principles, for an observer on a moving system not being able to perceive his own motion. A. D.

33. *Einstein General Relativity and Mercury's Perihelion Anomaly.* **G. v. Gleich.** (Ann. d. Physik, 72. 3. pp. 231–235, Aug. 7, 1923.)—The author subjects Einstein's general relativity theory, defined by the condition that $ds^2 = \Sigma g_{ik} dx_i dx_k$ $(i, k, = 1, 2, 3, 4)$ should be an invariant, to a searching and detailed mathematical criticism. He also considers and compares the expressions obtained by various mathematicians, *e.g.* Gauss, Riemann, and Gerber. The latter, in 1898, obtained with his potential exactly the same equation as that of Einstein, but as the author points out, the derivation of his potential cannot be regarded as satisfying. He points out, further, that it is not sufficiently recognised that Einstein's gravitation theory, as he has shown in this paper, is dependent on a series of purely arbitrary assumptions. The author's conclusions from his examination are: (1) That it is open to doubt whether or no the Einstein formula for the anomaly is really in accordance with the observations; (2) that, even if it so be, this does not afford a valid foundation for Einstein's general relativity theory, nor does it substantiate the claim that gravitation in the neighbourhood of large masses of matter is a consequence of the metric of the defining fourfold.

G. W. DE T.

34. *An Infinite Potential and a Mean Stellar Velocity Equal to that of Light.* **E. Selety.** (Comptes Rendus, 177. pp. 250–252, July 23, 1923.)—In a universe composed of systems with dynamical similarity, the potential is infinite. Seeliger's objection to such a universe is not valid. It suffices that the acceleration at any point is less than a given quantity, and if the mean density decreases more rapidly than $1/r$ this condition is fulfilled. Einstein claims that the difference of potential to infinity cannot be greater than that necessary to account for the mean velocities of the distant stars. The theory of a spherical mass of gas, on Darwin's analysis of a swarm of meteorites, shows that equilibrium is possible statistically in a universe of infinite mass and potential but with a small mean velocity.

Considering the velocities of component systems on the classical theory, the root-mean-square velocity of the first order systems with reference to the centre of mass of the nth order system is $r\sqrt{n}$ where r is the relative velocity of any system of order n with respect to the centre of mass of the system of order $n + 1$. From the restricted theory of relativity is obtained the analogous expression: $r_n = e\sqrt{1 - (1 - r^2/c^2)^n}$. Then the mean velocity of all bodies of the same order is equal to c, but any particular value is less than c.

A. Wh.

METEOROLOGY AND GEO-PHYSICS.

35. *The Mechanism of Cyclones and Anticyclones.* **T. Kobayasi.** (Roy. Meteorolog. Soc., J. 49. pp. 177–188; Disc., 188–189, July, 1923.)—The instantaneous lines of flow are calculated for a cyclone assuming that the barometric gradient is constant in the central region, and that there is neither an ascending nor a descending current outside this region. It is shown that, if there is a horizontal gradient of temperature perpendicular to the motion of the cyclone, temperature discontinuities occur which correspond with the squall line and the steering line. It is shown by similar treatment that two slight discontinuities of temperature occur in the rear of an anticyclone.

A. W. L.

36. *Origin of Cyclones.* **H. Ficker.** (Meteorolog. Zeits. 40. pp. 65–79, March, 1923.)—This paper is a critical review of the V. Bjerknes' polar front theory of the origin of cyclones. W. A. R.

37. *Cyclones.* **W. Milch.** (Meteorolog. Zeits. 40. pp. 104–108, April, 1923.)—The general equations upon which Bjerknes' theory of atmospheric vortices depend are developed from general hydrostatic considerations, and in addition reference is made to assymetric cyclones. W. A. R.

38. *Ascent of Rubber Balloons.* **Y. Horiguti.** (Imp. Marine. Obs. Kobe, Japan, 1. pp. 37–51, March, 1923. In English.)—The rate of ascent is expressed fairly simply. But for higher altitudes a complex correction has to be applied, depending on density ratios. A table of densities is added and enables the calculation of the velocity of ascent to be quickly made. Differences between the calculated and observed rates of ascent are to be ascribed to air currents. W. A. R.

39. *Atmospheric Circulation.* **F. M. Exner.** (Meteorolog. Zeits. 40, pp. 14–19, Jan., 1923.)—The energy manifested in atmospheric circulation may on the one hand be derived from consideration of gravitational energy, or on the other from considerations of an adiabatic cycle. The paper in the first instance works out the affinities of these two points of view. In the second place attention is given to Sandström's theory. This observer distinguishes two types of vortex—one in which the transfer is mainly vertical, and the other (called a *slide-vortex*) in which the transfer is mainly horizontal. The energy conditions of this type are also worked out, and considered to have fruitful meteorological applications. W. A. R.

40. *Constitution of the Upper Strata of the Atmosphere.* **L. Vegard.** (Phil. Mag. 46. pp. 577–604, Oct. 1923.)—Spectra of aurora have been obtained corresponding with different altitudes; these show that the intensity of the green line, compared with the negative bands of nitrogen, is greater near the bottom edge than 50–80 km. higher up. This shows that the green line must be emitted either from nitrogen or some compound of nitrogen; also that nitrogen must be a predominant component of the atmosphere to its upper limit. These results are in accordance with the results of previous investigations of the constitution of the upper atmosphere by the same author. [See Abstracts 2104–2106 (1923).] A. W. L.

41. *Atmospheric Permeability for Light, etc.* **A. Gockel.** (Meteorolog. Zeits. 40. pp. 129–138, May, 1923.)—The paper records and discusses the results of observations with a Michelson actinometer carried out at Freiburg, in Switzerland. The turbidity factor, the total and red radiations, and the amount of polarisation are given for parts of the years 1921–1922. W. A. R.

42. *Characteristics of the Atmosphere up to 200 Kilometres as Indicated by Observations of Meteors.* **G. M. B. Dobson.** (Roy. Meteorolog. Soc., J. 49. pp. 152–165, July, 1923.)—The physical processes taking place in the atmosphere around a meteor have been described in a previous paper [Abstract 1069 (1923)]. The calculation of the density of the air from the observed properties of meteors leads to the conclusion that the temperature remains constant from the tropopause up to about 50 km., and that above this height there is a region in which the temperature is much higher. This higher temperature may be accounted for by the absorption caused by the presence of a layer of ozone, which might be formed from the oxygen under the action of the extreme ultra-violet radiation from the sun. About 5 % of the solar energy reaching the atmosphere is absorbed by ozone; if this occurs at great heights a high temperature at these heights would result.

The height of disappearance of meteors seems to be higher in summer than in winter, which is in accordance with the suggestion that the temperature in the upper layers is governed by the absorption of solar radiation. The observations seem to show that nitrogen and oxygen are the chief constituents of the atmosphere up to about 160 km., and that at about 200 km. helium probably predominates. A. W. L.

43. *Volume Change in Rising Air.* **S. Róna.** (Meteorolog. Zeits. 40. pp. 39–47, Feb., 1923.)—The volume change in rising air, under adiabatic conditions, is worked out for three cases: for dry air, for moist unsaturated, and for saturated air. The equations arrived at are then applied to the estimation and prediction of the amount of rainfall. W. A. R.

44. *Solar Radiation Corrections.* **R. E. Watson.** (Meteorolog. Office, Geophys. Mem. 3. 21. pp. 1–17, 1923.)—The corrections obtained by a comparison of Ångström and Abbot pyrheliometers used at Kew are given and discussed; and a table of corrections to be applied to values of the intensity of solar radiation already published in the Geophysical Journal between 1907 and 1921 is appended. W. A. R.

45. *Ultra-Violet Intensity of Solar Radiation.* **G. M. B. Dobson.** (Roy. Soc., Proc. 104. pp. 252–271, Sept. 1, 1923.)—The intensity of the sun's radiation of λ3200–3150 is determined by photographing the disc through a silver absorption screen. On the same plate is photographed an Ilford wedge illuminated by a standard lamp, and the densities are compared by a photoelectric cell and galvanometer. The logarithm of the intensity is plotted against the secant of the sun's zenith distance, Z, when the intensity extrapolated for sec. Z = 0 gives the intensity in free space and the slope gives the atmospheric transmission coefficient. Observations are made on 34 days in 1922, and it is found that the variations are far greater than would be expected from variations of the solar constant, 30 % being a normal value. The transmission coefficient also varies from 0·22 to 0·42. The ratio of central to limb brightness varies only slightly from day to day. The conclusion is reached that the scattering in the atmosphere is due to particles far smaller than those causing normal "haziness." A. Wh.

46. *Victoria and Albert Lake Levels.* **C. E. P. Brooks.** (Meteorolog. Office, Geophys. Mem. 2. 20. pp. 337–344, 1923.)—There is only a small correlation between the lake levels and the rainfall, but a very high one indeed between the levels and the sun-spot variation, even when the monthly records are used and no correction for lag is made. Such a connection can only be obtained through the evaporation. W. A. R.

47. *Elastic Constants of the Earth's Interior.* **B. Gutenberg.** (Phys. Zeits. 24. pp. 296–299, July 15, 1923.)—The coefficient of rigidity increases from 3×10^{11} C.G.S. units at the earth's surface to 32×10^{11} at its centre. A. D.

48. *Causes of Earth Movement.* **J. Joly.** (Phil. Mag. 45. pp. 1167–1188, June, and pp. 170–176, July, 1923.)—This paper outlines a novel theory as to the origin of earth movements, designed to account for their cyclic character with attendant igneous activity during geological time. The data of isostasy and the existence of a layer of basalt beneath the immediate crust are assumed. The basalt is somewhat variably radioactive. The conservation of this heat must ultimately liquefy the basalt layer. The melting will cause expansion and the whole earth will undergo a radial expansion. Subsequent cooling taking place more rapidly under the ocean than under the continents causes a contraction, as the net result of which the continental masses are raised. The lateral motion evidenced in mountain building may arise partly by circumferential changes accompanying the radial; partly through tidal and precessional effects acting on the liquid or partially liquid layer. The process then begins anew, and the earth therefore goes through a series of small pulsations, for which the energy is derived from radioactive disintegration.

In the second paper the extent of the differential movements of the crust and the probable distribution of sub-crustal temperatures are estimated. W. A. R.

49. *Seismograms.* **S. K. Banerji.** (Indian Assoc. for Cultivation of Science, Proc. 8. 1. pp. 47–50, 1923.)—It is suggested that the prolonged, small amplitude disturbances (the earthquake coda), which follow the long wave phase in the seismogram, are equivoluminal waves partly transformed into Rayleigh waves on reaching the surface. That they arrive relatively late is explained as due to their having suffered one or more surface reflections. W. A. R.

50. *Earthquake Main Waves.* **K. Suda.** (Imp. Marine Obs. Kobe, Japan, 1. pp. 52–65, March, 1923. In English.)—The paper contains an investigation into the energy conditions of the main earthquake waves in the neighbourhood of the origin. The earth's crust must be assumed to be heterogeneous, and results derived from the study of distant quakes are inapplicable. The distribution of the energy from the epicentre is not logarithmic. The extraordinary energy values obtained for some near earthquakes are partly explained by wrong seismometer constants, and partly by geological conditions. For a near earthquake the energy distribution can be explained to some extent on the wave diffraction theory. The type of energy distribution depends on the direction of first motion at the seismic origin. In Japan moderate and weak shocks are produced by a vertical, and violent shocks by a horizontal, motion at the seismic origin. W. A. R.

51. *Visco-Elasticity and Seismic Waves.* **Nina M. Hosali.** (Roy. Soc., Proc. 104. pp. 271–278, Sept. 1, 1923.)—In dealing with the "viscous" properties of the outer crust of the earth previous workers have taken account of the viscosity by adding a frictional term. The author proposes to assume a stress-strain law, and deduce from it the laws of wave propagation. The law used is derived by adding the ordinary elastic solid stresses to the stresses in a viscous fluid. The law agrees so far with experiments on solids that it involves a term implying an instantaneous strain proportional to the load. The strain thereafter follows an exponential law and attains its final value asymptotically. The law is applied to the determination of waves in a visco-elastic medium. W. A. R.

ASTRO-PHYSICS.

52. *Declinations of 526 Stars.* **S. G. Barton.** (Astron. J. 34. pp. 175–181, Dec. 22, 1922.)

53. *Light Absorption in Space.* **A. Kopff.** (Zeits. f. Physik, 17. 4–5. pp. 279–286, 1923.)—After a detailed discussion of the evidence, the author arrives at the conclusions: That the results of counting the stars in the 32 selected areas are in good agreement with the assumption that there exists a layer of light absorbing substance extending over the greater part of the heavens: That such a layer must be of relatively small thickness; that the optical density of such a layer must vary greatly in its distribution within the limits of the Milky Way, vary much less outside these limits, and decrease as the distance from the poles of the Milky Way increases; that the distance of the absorbing layer from the sun must be between 300 and 500 parsecs within the Milky Way, and somewhat less outside these limits. How far such an assumption may be in contradiction to other results of observation cannot at present be answered. The proper motions of the fainter stars, which might decide the question, are as yet for the most part unknown. G. W. de T.

54. *Is the Velocity of Light to be Compounded with that of its Source?* **M. la Rosa.** (Accad. Lincei, Atti, 32. i. pp. 590–598, June 17, 1923.)—The hypothesis that it is so to be compounded (ballistic hypothesis) enables many of the phenomena of double or variable stars to be explained. A. D.

55. *General Orbits of Trojan Group of Asteroids.* **E. W. Brown.** (Astron. J. 35. pp. 69–80, Aug. 10, 1923.)—The true orbital longitude of the asteroid is taken as the independent variable. The chief feature in a Trojan's motion is due to resonance. Since it has only one fundamental short period, a Trojan must follow Jupiter both in mean motion and elliptic orbit, and Jupiter compels it to have nearly the same secular nodal motion as itself, and prevents it having any large inequality of long period, due to the direct attraction of any other planets. The author shows that the Trojan group is stable, but it is possible that the gaps in asteroidal distribution between Jupiter and Mars may be due to resonance. A. S. D. M.

LIGHT.

56. *Prism Method of Determining the Refractive Indices of Metallic Vapours.* **H. G. Smith.** (Roy. Soc. Canada, Trans. 16. Sect. 3. pp. 145–150, 1922.)—Experiments are described in which the refractive indices of the vapours of Hg, Tl, and Ca are studied by means of modifications of the method described by J. C. McLennan [see Abstract 837 (1922)]. The deflection produced by the quartz plates forming the sides of the prism is comparable, apart from other sources of error, with the whole effect when the prism is filled with Tl vapour. Annealing of the plates affords no improvement. Except in the case of Hg, where a lower temperature (320° C.) can be employed, the method is regarded as unsatisfactory. A. B. C. L.

57. *The Visibility Curve.* **T. Ōtashiro.** (Phys. Math. Soc. Japan, Proc. 5. pp. 57–59, May, 1923. In English.)—The curve consists very nearly of two probability curves. Joly's view confirmed that photographic "vision" and the vision of sight are fundamentally alike, both being photoelectric. A. D.

58. *Accommodative Reflex of the Eye.* **A. Polack.** (Comptes Rendus, 176. pp. 407–408, Feb. 5, 1923.)—Accommodation of the eye to different distances operates without the action of the will by contraction of the ciliary muscle. It is supposed that this reflex has its origin in the circles of diffusion produced on the fovea by the objects to which the eye is not accommodated at the instant when they attract attention. In the present paper the author discusses the mechanism by which sometimes a contraction, sometimes a relaxation of the muscle is brought about. Spherical aberration in the eye is inconstant, varying from eye to eye and in different accommodative states; it can in certain cases be zero or negative. On the other hand, chromatic aberration exists in all eyes, and is always present in the same sense. Logically, the latter should be the principal factor determining the accommodative reflex. From this point of view, what has been considered as a simple optical fault plays a useful part and deserves to be classed amongst the physiological factors of vision. T. H.

59. *Limits of Visual Acuity.* **T. Y. Baker.** (Phil. Mag. 46. pp. 640–642, Oct., 1923.)—The author comments on a communication by H. Hartridge [Abstract 2138 (1923)], discussing ability of the eye to assign a datum mark between two successive divisions of a scale. The test was based on attempts to subdivide a millimetre into tenths when placed 25 cm. away from the eye. But the importance of the magnitude of angle subtended has been overlooked. There is an optimum angle for which interpolation acuity reaches a maximum—apparently about 3°. Hence an attempt to subdivide 1 cm. placed at the near point of vision would yield better results. In these circumstances it was found possible to estimate the position of the datum mark accurately to 1/50 of a division, whereas the error involved in Hartridge's attempt to subdivide 1 mm. was

so great that the inaccuracy is nearly 1/5. It is unnecessary to employ a vernier if it is not required to subdivide a scale division below 1/50 part, provided the angular value of the scale division at the eye is about 3°. The author also mentions an experience with a prismatic astrolabe. In the use of this instrument the error was reduced to 1/3 by inserting a small prism producing a double image of a star instead of a single one. An image can be brought into coincidence with two duplicate images with greater precision than is possible when only two single images are used.
J. S. D.

60. *The Relation between Field Brightness and Speed of Retinal Impression.* **P. W. Cobb.** (Frank. Inst. J. 195. pp. 855–857, June, 1923.)—A brief description is given of experiments on the above subject, and results are presented in tabular and graphical form. The experiment consisted in the observation of the time of exposure necessary in order that the subject might correctly state whether or no a black circular dot in the centre of a white screen has been shown, the brightness being varied over two ranges, from 3·3 to 31·3 candles per sq. m. and from 24·8 to 342 candles per sq. m. The reciprocal of mean threshold time (expressed in thousands of a sec. [δ]) is plotted as ordinate, the brightness as abscissa. Increasing brightness materially diminished the time, which varied from 7·3 to 28·7 δ for the range of brightness specified. The relation is roughly linear.
J. S. D.

61. *A Flicker Type of Photoelectric Photometer giving High Precision* **G. M. B. Dobson.** (Roy. Soc., Proc. 104. pp. 248–251, Sept. 1, 1923.)—In recent years the photoelectric cell has proved useful for the estimation of densities of filters or photographic plates, but the ordinary method has drawbacks. It is customary to obtain readings successively with the specimen studied and a neutral glass wedge, which is adjusted to give the same deflection on the galvanometer. It is, however, necessary to take great care to ensure that the apparatus remains constant during the observations, and much time is apt to be wasted in repeating and checking results. Moreover, when large densities have to be measured the deflection is small and the accuracy is relatively poor. The author has devised an improved method based on the flicker principle. Two beams of light are taken from an electric lamp with a small compact filament. Both beams fall on the photoelectric cell, one having passed through the plate whose density is to be tested, the other through an adjustable standard optical wedge. A shutter revolving round the lamp shuts off each beam alternately. Hence if the wedge is adjusted so that there is no oscillation of the galvanometer the densities of standard and plate may be assumed to be equal. The apparatus is made very sensitive, so that for small densities only a weak light is necessary; for higher densities the resistance in series with the galvanometer may be diminished, so as to obtain the same deflection. It is unnecessary that the zero position of the galvanometer should appear in the field of view, and the maximum deflection conducive to accuracy may be used. The density is obtained in one operation, and great constancy in the photoelectric cell or light source is not necessary. A fibre electrometer and a resistance of about 10^{-9} ohms is found convenient. The shutter must be accurately made, and a speed of one to five revs. per min. was found satisfactory. In favourable circumstances the probable error is less than 1/10 per cent. for one observation. J. S. D.

62. *Apparatus for Determining Mean Spherical Candle Power.* **J. Sahulka.** (Elek. u. Maschinenbau, 41. pp. 530–532, Sept. 9, 1923. Similar article in Elektrotechnische Zeitschrift, July 12, 1923.)—The customary apparatus for determining mean spherical c.p. has drawbacks. Mirror arrangements are only suited for sources of small dimensions; otherwise a complete image of the source may not be seen at the photometer. The Ulbricht sphere is subject to various sources of uncertainty and must be at least 1½ m. in diam. in order to keep errors small. The author has substituted plates of plaster of Paris for the series of mirrors commonly arranged at requisite intervals round the light-source in order to yield m.s.c.p. The aggregate light from all these surfaces impinges on the photometer, and it is only necessary to see that no shadow is cast on the screen by the housing of the instrument. Such plates are, however, liable to crack, and strips of suitable paper have been substituted. This has led to the idea of utilising a continuous encircling surface instead of a number of white surfaces at intervals. This complete strip of paper is conveniently arranged in a rectangle, with the source at its centre. The necessary correction for zones of equal area is automatically secured for the vertical sides of the rectangle by the variation in the cosine of the angle of incidence. The width of the vertical strips may therefore be uniform, but the horizontal strips above and below the source must vary in the width, the contour being calculated to ensure equal zones. The apparatus is calibrated in the usual way by substituting for the source tested a lamp of known mean s.c.p. J. S. D.

63. *Absorption of Light by Sodium Vapour.* **F. H. Newman.** (Phil. Mag. 46. pp. 420–425, Sept., 1923.)—Unexcited sodium vapour shows absorption corresponding to the principal series lines only. If, however, the atoms can be brought to the condition that a considerable proportion have the electron in the $2p$ ring, then the radiation absorbed when white light is passed through the vapour will be the lines which in the emission spectrum arise when the electron is displaced from the $2p$ ring to outer stationary orbits, *i.e.* the subordinate series lines. Experiment indicates the probability that this abnormal state of the vapour can be produced not only by electrical stimulation, but also by high temperature. An account is given in this paper of a continuation of experiments previously described [Abstract 2155 (1923)]. The radiation from a sodium-potassium alloy vapour arc lamp was sent through feebly luminous sodium vapour. The subordinate series lines of sodium decreased in intensity. White light from an electric arc passed through this feebly luminous vapour showed absorption of λ6161, λ6154, λ5688, λ5683 lines belonging to the subordinate series. These effects are explained by the presence of atoms in an abnormal state, this state being brought about by an electrical stimulus. The valency electron of these atoms is in the first p ring. J. J. S.

64. *The Photometric Matching Field.* **L. C. Martin.** (Roy. Soc., Proc. 104. pp. 302–315, Sept. 1, 1923.)—In photometers of the "equality of brightness" type it is accepted that the minimum contrast perceptible depends upon (1) brightness of the retinal image of the field, (2) state of adaptation of the eye, (3) the portion of retina employed for visual observations, and (4) the size and shape of the contrasting patches. The first section of the paper is devoted to a summary of previous work on this subject from which the conclusion is drawn that maximum sensitiveness necessitates both parts of the field of view having a minimum angular subtense, and also on working as large as possible an extent of the area at a fairly uniform level of brightness. The second part of the paper is concerned with securing the latter condition and thus increasing the accuracy of photometric measurements. It is usually inconvenient to obtain an optical magnification enabling the field to subtend an apparent angle exceeding 1° to 4°. But it is possible to surround the matching field by a field of about the same brightness. The author attained this condition by means of an adjustable aperture on the top of the photometer admitting extraneous light on to a screen through which the field was viewed. Preliminary experiments with such apparatus indicated a decided improvement in precision of setting as a result of this device, and more detailed tests confirmed this result. In one set of readings the mean error with light-surrounding field was 0·29 per cent., with dark-surrounding field 0·62 per cent.; in a second series, values of 0·47 per cent. and 0·76 per cent. were recorded. The beneficial effect of this device appears to be established, but the problem is now to be attacked in a more methodical way. J. S. D.

65. *Increasing the Dispersion of a Constant Deviation Spectroscope.* **J. F. T. Young.** (Optical Soc. of America, J. and Rev. Sci. Inst. 7. pp. 405–406, May, 1923.)—The difficulty was completely solved by inserting one or more extra prisms between the telescope and the prism, and using direct vision trains in place of ordinary prisms. The intensity was still sufficient. A. D.

66. *Apparatus for the Polarisation of the Light of the Sky.* **A. Hofmann.** (Zeits. Instrumentenk. 43. pp. 232–235, July, 1923.)—Simple apparatus for this. A. D.

67. *Dispersion Investigated by an Interference Method.* **H. F. Dawes.** (Roy. Soc. Canada, Trans. 16. Sect. 3. pp. 283–292, 1922.)—Considers the interference fringes of an interference system for which the two paths are of unsymmetrical dispersion. With white illumination the fringes form closed curves centring on the wave-length for which the number of wave-lengths in the difference of path is a maximum. These are illustrated by spectrograms with sunlight illumination. The numerical results give the dispersive power of the substance to a high degree of precision. A. D.

68. *A New Magneto-Optic Phenomenon.* **M. Holmes.** (Phil. Mag. 46. pp. 335–336, Aug., 1923.)—Glycerine in a polarimeter is exposed to a longitudinal magnetic field; the uniform field of view is partly darkened when the field is turned on. Now switch off the magnetic field, and watch; the field of view dies out and reappears with its light and dark areas reversed before finally regaining uniformity. Non-viscous liquids give no such result; nor do liquids more viscous than glycerine. A. D.

69. *Polarisation of the Light Scattered by Gases and Vapours.* **C. V. Raman** and **K. S. Rao.** (Phil. Mag. 46. pp. 426–434, Sept., 1923.)—Lord Rayleigh and others have shown that the light scattered transversely by gases is not in general perfectly polarised, but shows a defect of polarisation which at ordinary temperature and pressure is characteristic of each gas. This result has been explained as due to the optical anisotropy of the scattering molecules which is different for different gases. With monatomic gases such as argon, the scattered light is almost completely polarised, while more complex molecules show a very marked imperfection of polarisation. In Rayleigh's experiments a photographic method was used. The authors have made experimental arrangements by means of which direct *visual* measurements are possible and have examined various gases and vapours. The results obtained are as follows, where the figures give the ratio of the weak to the strong component of polarisation as a percentage: H_2, 3·6; O_2, 8·4; CO_2, 10·6; Air, 4·37; N_2O, 14·3; Benzene, 6·8; Pentane, 2·8; Ether, 3·0. These values for the imperfection of polarisation of gases are much higher than those of previous investigations except those got in Rayleigh's final work. In the case of the five gases Rayleigh's final values are distinctly higher than those of the authors. J. J. S.

70. *Law Connecting Position of Object and Image in a Simple Lens.* **E. Schwarez.** (Zeits. f. Physik, 16. 5–6. pp. 340–344, 1923.)—The author gives a mathematical description of the path traced out by the object when (*a*) the lens is stationary and the object moves along a line parallel to the axis, and (*b*) the object is stationary and the lens moves along its axis. In the second case the path of the image is a hyperbola for which the characteristics are given in the paper; in the first case it is a straight line. The two cases of the bi-convex and bi-concave lens are treated separately, and the author points out, in conclusion, that the straight line path on a system of coordinates moving with the lens is equivalent to a hyperbola or a system of coordinates considered as fixed with respect to the object. **Errata** (*Ibid.* 17. 4–5. p. 352, 1923). J. W. T. W.

71. *Unit Curves of a Photographic Lens.* **Alice Everett.** (Phil. Mag. 46. pp. 565–567, Sept., 1923.)—This is a continuation of previous work on this subject [see Abstract 1558 (1923)]. The unit curves, *i.e.* the loci traced out by pairs of conjugate points for unit magnification on rays fulfilling some condition, are traced out for an axial section of a Tessar photographic lens for three different positions of an infinitely distant source, namely, with the incident ray inclined at 0°, 5° and 20° to the axis. The results are shown in diagrams, and it is found that: (1) The position of the unit curves changes with that of the source, *i.e.* with the inclination of the parallel pencil of chief rays: (2) The curvature changes with the position of the source: (3) The curvature changes also with the aperture or incident height; the curves are not circular, nor plane. Hence the object curves cannot coincide with the incident wave-front, which is plane: (4) The unit curve in the image space, like the wave-front, is more convex to the source than the curve in the object space. J. W. T. W.

72. *Effect of Pressure upon Optical Absorption.* **F. G. Wick.** (Am. Acad., Proc. 58. pp. 557–573, Aug., 1923.)—The author describes apparatus used for studying the effect of pressures up to 3500 atmospheres on the absorption characteristics of certain substances, notably those showing well-marked absorption bands. Results for the following substances are given in the paper: Aqueous solutions of salts of the rare earths neodymium, praseodymium, erbium, and "didymium"; aqueous solutions of the uranyl salts; aqueous solutions of cobalt chloride; a synthetic ruby; samples of coloured glass. The effect of pressure is, in general, similar to that which takes place upon lowering the temperature of a substance or decreasing the concentration in the case of a solution. In most cases an absorption band is made sharper and shifted towards the violet. The results given are mainly quantative, but it is considered that the effect of a pressure of 3500 atmospheres is equal to a lowering of the temperature to about − 60° C., while an increase of 1700 atmospheres pressure upon a 0·2 normal solution of neodymium nitrate is approximately equivalent to a reduction of the concentration of this solution to one-half its value, that is, to making the concentration of the solution 0·1 normal. J. W. T. W.

73. *Pleochroic Haloes.* **J. Joly.** (Roy. Soc., Proc. 102. pp. 682–705, March 1, 1923.)—Black Archæan micas often show bleached haloes, *e.g.* those of ytterby. The bleaching is clearly a radioactive effect, and is accounted for by a "reversal" theory, analogous to the photographic phenomenon where long exposure reverses the image. Several new types of ringed haloes are described. Renewed measurements of haloes from rocks of different ages indicate a distinct increase of radial dimensions with increasing age. [See Abstract 1642 (1922).] W. A. R.

74. *The Size-Frequency Distribution of Grains of Silver Halide in Photographic Emulsions, and Its Relation to Sensitometric Characteristics. V. Systematic Correlation.* **E. P. Wightman, A. P. H. Trivelli,** and **S. E. Sheppard.** (J. Phys. Chem. 27. pp. 465–480, May, 1923.)—In previous papers [see Abstracts 493 and 1124 (1923)] the authors have discussed the various methods in vogue for obtaining the size-frequency distribution of the grains of a disperse system, and also described in detail that employed in the case of photographic emulsions. The sensitometric and size-frequency distribution characteristics of a number of commercial and of a few experimental emulsions were correlated as far as possible and a tentative general theory of the correlation proposed. In the present paper a series of photographic emulsions is considered which are much more closely related to each other than those previously studied, and strictly comparable because practically all the factors in their preparation have been under control, only one being varied so as to increase progressively the speed of the emulsions in the series; and also because equal weights of the emulsion containing in every case the same amount of silver halide by weight were coated on the plates. The equations which represent the grain-size distribution of these emulsions show a steady transition from a steep exponential, $y = y_0 e^{-kx}$ to a flat, widely spread Gaussian type, $y = y_0 e^{-h(x-a)^2}$, *i.e.* in passing through the series from the slow to the comparatively fast emulsion the parameters y_0 and k steadily decrease, while the parameter a, which is zero in the first two examples, then steady increases. Other grain characteristics have been determined, and they likewise exhibit the same progressive increase or decrease with the speed. H. H. Ho.

75. *The Relation of the Selective Absorption of Printing Colours to the Errors Occurring in Three-Colour Photography.* **A. J. Bull.** (Phot. J. 63. pp. 403–422; Disc., 422–424, Sept., 1923.)—An introductory reference is made to the work of Clerk Maxwell, du Hauron, Joly, Ives, Lumière, and Sanger Shepherd in connection with the progress of three-colour photography and printing, and the results discussed in relation to the present experiments. The author describes his own experiments, which were made to ascertain how far the want of a complementary relation is responsible for the inaccuracies in the three-colour half-tone method; and refers to the application of such knowledge in the present great extension of "offset" lithography. The method of experiment is described, and the experimental results are given in graphical form. An examination is made of some component printings, and the effect of printing with ideal inks is considered in relation to the experimental results. The general conclusions arrived at are that in the course of reproduction certain definite changes of colour occur. (1) The blues become darker and greyer. (2) Blue greens lose their greenish hue. (3) Greens become darker and greyer. (4) Pinks become a yellow hue. (5) Mauves become brown. (6) Reds lose any bluish tint they may possess. (7) Yellows are lightened without change of hue, while oranges and browns are well reproduced. (8) No change in the character of the reproduction takes place with variation of tone with the colours yellow, blue, and green. (9) In the scale of tones from black to white there is a tendency for the middle tones to become reddish. (10) The lightening of yellow in reproduction is due to a very light yellow printing ink being used. (11) The inks are transparent enough for the usual effect of superposed printings to be capable of approximate calculation. (12) The major errors of the reproduction can be removed if each ink absorbs one of the three primary regions only. The author concludes by stating that there is little immediate hope of supplying printing inks of the required theoretical character, and that it will be necessary to devise suitable methods of correction as the method of three-colour printing is extended into fresh fields. A. W. J.

76. *Rotatory Dispersion in Fluorescent Solutions.* **A. Carrelli.** (Accad. Lincei, Atti, 32. i. pp. 272–277, March 18, 1923.)—Ethyl-alcohol solutions of quinine chloride, sulphate and bisulphate do not show a circular dichroism in the fluorescent emission analogous to that found by Cotton in absorption. The addition of a few drops of sulphuric acid increases not only the fluorescence but also the rotatory power. The three salts give effects which differ in detail; and the fluorescence in them seems related, according to Perrin's theory, to a molecular modification brought about by the action of light. A. D.

77. *Destruction of Fluorescence by Ultra-violet Light.* **(Miss) F. M. Cale.** (Roy. Soc. Canada, Trans. 16. Sect. 3. pp. 257–263, 1922.)—Measurements of the decrease of fluorescent intensity in a solution of æsculine exposed to ultra-violet light. After the solution was once exposed it continued to decay although kept in absolute darkness. On exposure to u.-v. light the rate of decay decreased very rapidly at first, then steadily. On recommencing the exposure after an interval of several hours, the rate of decay was more rapid than before the interval. Ozone caused a very rapid decay, producing a solution similar to that transformed by u.-v. light. A. D.

78. *Polarised Phosphorescence.* **A. Carrelli** and **P. Pringsheim.** (Zeits. f. Physik, 17. 4–5. pp. 287–291, 1923.)—It has been found by simple methods of observation that the phosphorescent radiation of a solid solution of eosin in gelatine is partially polarised if it is excited by linearly polarised light. The degree of polarisation of about 21 % is practically independent of the time which elapses between excitation and the moment of observation. J. J. S.

79. *Fluorescent Tubes. Radiations which Excite Fluorescence.* **Risler.** (Soc. Franç, Élect., Bull. 3. pp. 293–306, July, 1923.)—The object of this paper is the production of the phenomena of fluorescence by different radiations arising in mixtures of rarefied gas at the most suitable pressure. After analysing the effects produced by the sources of energy which bring about these phenomena, such as X-rays, kathode rays, etc., researches are described showing the results obtained with an electric discharge by a high-frequency current through tubes of rarefied gas and pointing out the action of different gaseous mixtures upon the fluorescent screens. After having explained the difficulties met with from the point of view of the formation of the tubes, the author enumerates the industrial applications arising out of the results of this work. A. E. G.

80. *Changes in Spectral Lines.* **C. Füchtbauer, G. Joos, and O. Dinkelacker.** (Ann. d. Physik, 71. 1–4. pp. 204–227, May 23, 1923.) —Changes in the breadth and form of the absorption line Hg 2537 on the addition of a range of foreign gases under a wide range of pressures; the law of increase of the line-breadth with increasing density of the added gas; the dependence of the absorption (reduced to equal atomic numbers) on the density of the added gas, and the absolute values of the absorption so reduced. Displacements of the maximum of absorption lines towards greater wave-lengths, with increasing density of the added gas. A. D.

81. *Standards for Short Wave-lengths.* **S. K. Mitra.** (Annales de Physique, 19. pp. 315–339, May–June, 1923.)—The author finds copper lines 2369·891, 2303·134, 2276·261, 2242·622, 2218·107, 2189·631, 2148·897, 2126·047, 2112·105, and a tin line 2334·816 in a gap between the copper lines. A. D.

82. *A Second Approximation to the Quantum Theory of the Simple Zeeman Effect and the Appearance of New Components.* **A. M. Mosharrafa.** (Phil. Mag. 46. pp. 514–524, Sept., 1923.)—In a previous paper [see Abstract 1133 (1923)] a first approximation to the theory of the simple Zeeman effect was put forward, based on the extended form of the quantum restrictions. It was found that the method of separation of the variables could be successfully applied in the presence of the field H, provided all terms of higher order than the first in H were neglected. In this paper it is shown that the method can still be applied, without any restriction as to the degree of approximation, to a hypothetical motion which possesses the same energy as the actual motion, and a second approximation to the theory of the simple Zeeman effect is worked out. The analysis takes account of the refinement of relativity, but it is shown that the second-order effect of this refinement is negligible compared with that of the field. The theory predicts a modification in the simple Zeeman triplet which may be described as a splitting of each of its 3 components into a number of "sub-components." The general character of these sub-components is discussed. The results are worked out fully in the case of Hγ for a hypothetical field of 10^6 Gauss, where second-order displacements ranging from $+ \cdot 03$ A to $- 1 \cdot 27$ A are predicted.

An appendix derives the value of $\int_0^{T_\psi} \sqrt{(1 - \beta^2 dt)}$ for the Bohr-Sommerfeld atom, where T_ψ is the time from $\psi = o$ to $\psi = 2\pi$.
H. H. Ho.

83. *Open-Spark Spectra in Chemical Analysis.* **C. A. v. Welsbach.** (Ann. d. Physik, 71. 1–4. pp. 7–11, May 23, 1923.)—Open-spark spectra are highly characteristic of the element, and in the case of the rare-earths it would be difficult otherwise to detect them. It is remarked that more general use of spectroscopy in chemical analysis would be advisable. A. C. M.

84. *Fluorescence and Absorption Spectra of the Alkalies.* **J. C. McLennan** and **D. S. Ainslie.** (Roy. Soc., Proc. 103. pp. 304–314, May 3, 1923.)—The alkali metals were distilled from a mixture of the chloride of the metal with calcium turnings, into the experimental pyrex bulb; during the process the bulbs were kept exhausted by a Langmuir pump. The bulbs were heated in an electric furnace, the spectra were recorded with a Hilger constant deviation instrument. Observations in the near infra-red were made with plates dyed with dicyanin A.

A channelled absorption spectrum is found for *potassium*, similar to that possessed by sodium. There are two regions, one of wave-length longer than the first member of the doublet series of K, and one near to the second member.

Rubidium has a fluorescence spectrum consisting of bands, whose positions were measured. No absorption spectrum could be found in the neighbourhood of the first two members of the doublet series. *Cæsium* has now been shown to have a channelled absorption spectrum on the short-wave-length side of the first member of the doublet series, and to possess a fluorescence spectrum in the near infra-red region not yet resolved into bands. The absorption spectrum has a wave-length distance between the bands which is a simple multiple of 24 Å.U. Preliminary results with *lithium* suggest a channelled absorption spectrum between $\lambda = 4000$ and $\lambda = 3000$. These were shown in a vacuum arc between lithium electrodes. A. C. M.

85. *The Ultra-Violet Arc Spectrum of Copper in Aluminium.* **X. Waché.** (Comptes Rendus, 177. pp. 39–41, July 2, 1923.)—An investigation carried out with varying proportions of copper in the alloy. At 60 per cent. of copper the copper spectrum was complete, and so was the aluminium spectrum; but the aluminium spectrum began to die out at about 80 per cent. of copper. As the percentage of copper is reduced, the copper lines successively fade out; those which persist longest are those which resist the introduction of increasing self-inductions in the discharge circuit. A. D.

86. *Combinations and Terms in the Helium Band-Spectrum.* **A. Kratzer.** (Zeits. f. Physik, 16. 5–6. pp. 353–366, 1923.)—Curtis

[Abstract 1606 (1922)] has shown relations to hold between certain lines in the band-spectrum of helium in the regions λλ6400, 4546 and 5730. The author holds that these combination-relations uphold his own theory, and disagree with that of Curtis. A general investigation is made, and it is concluded that the bands λλ6400, 4546 belong to the same system of electrons, the only difference being that a higher quantum-number is to be associated with the more refrangible band. The third band, λ5730, has the same end-term as the other two, but belongs to a different system; so that in Helium there are at least two different systems of bands. The calculations lead to an upper limit for the moment of inertia of the helium molecule, and it is exceedingly small. A. C. M.

87. *The Arc Spectrum of Celtium.* **J. Bardet.** (Comptes Rendus, 176. pp. 1711–1712, June 11, 1923.)—A detailed enumeration of the wave-lengths from 2300 to 3500 U.A. A. D.

88. *Grouping of Lines of Secondary Spectrum of Hydrogen.* **K. Basu.** (Phil. Mag. 46. pp. 417–420, Sept., 1923.)—Since the secondary spectrum of hydrogen is probably molecular, Bohr's relation $h\nu = W$ (heat of ionisation), based on the analogy of the atomic spectrum, does not apply, for H_2-gas is transparent to $\lambda = 3600$ Å.U., the limiting frequency, and its secondary spectrum extends to $\lambda = 3300$. The author investigates whether any of the lines are due to two hydrogen nuclei at a definite distance (assumed as $l \times 10^{-8}$ cm), with an electron revolving about them, and finds several coincidences, but suggests that another assumed distance might have afforded as many other coincidences. He concludes that it is premature to solve the problems of Na or Cl or the numerous theories of mono-molecular reaction, based on the Bohr rule. A. S. D. M.

89. *The Influence of Foreign Gases on the Secondary Spectrum of Hydrogen.* **S. Barratt.** (Phil. Mag. 46. pp. 627–629, Oct., 1923.)—It has long been known that the presence of foreign gases in a hydrogen vacuum tube enhances the Balmer series relatively to the secondary spectrum of hydrogen. This has been especially observed in the case when helium is present in the vacuum tube. Experiments with argon and with oxygen have now been made, and are described in this paper. It was found that argon alters the distribution of intensity in the secondary spectrum, but that the effect is much smaller than that produced by the same pressure of helium. The effect of oxygen was studied by an examination of the spectrum given by water vapour. In this case the Balmer series are strongly developed while the secondary hydrogen spectrum is bright enough to be photographed, though weaker than in pure hydrogen. The intensity distribution in the secondary spectrum is unaltered by the presence of oxygen. J. J. S.

90. *A Simple Method of Extending the Balmer Series of Hydrogen in a Vacuum Tube.* **R. Whiddington.** (Phil. Mag. 46. pp. 605–607, Oct., 1923.)—The hydrogen primary spectrum in the usual vacuum-tube discharge in the laboratory is limited to a few lines, α, β, γ, and δ only showing with any intensity. This is in contrast with the fact that in stellar spectra the series is complete. The author considers that in stellar spectra the conditions are different in two respects, the hydrogen being

(1) at a much lower pressure and (2) bombarded continuously and intensely by electrons from the hot interior of the star. These conditions have been partially reproduced in the laboratory by using a vacuum tube with a pressure below 1/1000 mm. of mercury in conjunction with a hot kathode of tungsten wire. With the kathode cold the discharge would not pass at this pressure, but when it was glowing hot a brilliant discharge passed, a current of several hundred milliamperes being possible. Photographs of this discharge showed that the intensity of the Balmer series was increased relative to the secondary spectrum and a considerable number of Balmer lines extending into the violet appeared. Of the primary series 19 or 20 members were traced and the relative intensities of δ to γ, γ to β and β to α were enormously increased. The first condition above causes the comparative isolation of the radiating atom and consequently the realisation of its possible outer orbits, and with the second condition there is greater opportunity of combination of the positive hydrogen ion with an electron rather than a negative hydrogen ion. J. J. S.

91. *Regularities in the Arc Spectrum of Iron.* **F. M. Walters, Jr.** (Washington Acad. Sci., J. 13. pp. 243–252, June 19, 1923.)—Tabulated observations of wave-lengths and a preliminary analysis of complex multiplets [Catalán, see Abstract 2411 (1922) among these.] A. D.

92. *Symmetrical Series of Lines in the Iron-Spectrum.* **A. Hagenbach** and **H. Schumacher.** (Ann. d. Physik, 71. 1–4. pp. 19–40, May 23, 1923.)—Four symmetrical series (in two sets of two pairs) have been discovered in the iron-spectrum, one group running off into the violet, and the other into the red. Frequencies and not wave-lengths are employed. The series can be expressed by three constants, and one variable, *viz.*:

$$\text{Group I, } \nu = 194{,}727 \pm \frac{11{,}412 \,.\, m^4}{(m^2 - 1{\cdot}3544\,m + 13{\cdot}581)^2}$$

$$\text{Group II, } \nu = 194{,}820 \pm \frac{11{,}743 \,.\, m^4}{(m^2 - 0{\cdot}5038\,m + 5{\cdot}7173)^2}$$

$$\text{Group III, } \nu = 271{,}515 \pm \frac{6{,}735\; m^4}{(m^2 - 0{\cdot}384\,m + 6{\cdot}48)^2}$$

$$\text{Group IV, } \nu = 271{,}588 \pm \frac{6136\; m^4}{(m^2 - 1{\cdot}20279\,m + 10{\cdot}4354)^2}$$

where $m = 2, 3, 4, \ldots$ except in Group I, in which $m = 3, 4, 5 \ldots$

The effect of pressure and the Zeeman effect are also discussed. A. C M.

93. *Spectral Lines of Iron.* **H. Nagaoka** and **Y. Sugiura.** (Nature, 112. p. 359, Sept. 8, 1923.)—A preliminary account of quadruplets in the iron arc. Details to be published in the Japanese Journal of Physics, vol. 2. A. D.

94. *Effect of Metallic Surfaces on Spectra of Mercury, Cadmium, Helium and Oxygen.* **L. Janicki** and **E. Lau.** (Ann. d. Physik, 71. 8. pp. 562–566, June 19, 1923. From the Reichsanstalt).—Mercury droplets

on the inside of a vacuum tube containing H at 0·1 mm. pressure intensify the secondary spectrum, and also a mercury band-spectrum can be observed. Experiments were made which showed that a semi-transparent inner coating of silver had a similar effect. A discharge through mercury vapour in a silvered tube produced the band-spectrum; also in cadmium vapour the band-spectrum of cadmium was intensified. In oxygen a similar effect was observed; but with helium there was no effect.
A. C. M.

95. *Spectra of Ionised Potassium and of Argon.* **P. Zeeman** and **H. W. J. Dik.** (Ann. d. Physik, 71. 1–4. pp. 199–203, May 23, 1923.)—The spark spectrum of potassium vapour corresponds closely with that of argon, with constant differences.
A. D.

96. *Spectra of Rare Earths.* **J. M. Eder.** (Ann. d. Physik, 71. 1–4. pp. 12–18, May 23, 1923.)—The spectra of Yttrium, Erbium, Thulium, Cassiopeium (= Lutecium), Aldebaranium (= Neo-ytterbium) Samarium, Europium, Gadolinium, "Eurosamarium," Terbium, "Welsium," and Holmium are discussed. Eurosamarium and Welsium were discovered and named by the author. For the most part the arc was used, with a concave grating. Thulium and Terbium are considered to be elements definitely, while Samarium is doubtful.
A. C. M.

97. *Structure of the Neon Spectrum.* **A. Landé.** (Zeits. f. Physik, 17. 4–5. pp. 292–294, 1923.)—A discussion of the peculiarities of the spectrum of neon. It appears that the neon terms form the beginning of a quintet system, of two triplet systems, and of a singulet system. It seems that in the case of neon not only the L_1 terms but also the L_2 terms are due to the expulsion of the luminous electron from the 2_2 layer. In the Zeeman effect of neon support is given to the author's view of the nature of the Röntgen term positions according to which both L_1 and L_2 come about through disturbance of the 2_2 shell and only L_3 through disturbance of the 2_1 shell.
J. J. S.

98. *A New X-Ray Secondary Radiation.* **W. Bothe.** (Zeits. f. Physik, 16. 5–6. pp. 319–320, 1923. From the Reichsanstalt.)—Describes experiments on cloud condensation by ionisation after the Wilson method, an X-ray beam being used as the ionisation agent. The photographs of the X-ray bundel show in their course smaller ball-shaped clouds whose formation the author attributes to secondary atomic H radiations, the range of which according to the Bohr absorption theory is not greater than the order of a millimetre. The author recognises his theory is not proven, and proposes to carry out other experiments to obtain conclusive proof.
B. J. L.

99. *X-Ray Analysis of Materials.* **F. Körber.** (Zeits. Elektrochem. 29. pp. 295–301, July, 1923.)—Reference is made to changes in metals which occur with temperature variations due to a change in crystalline structure and rearrangement of the atomic space grid. The changes may be investigated by means of the Debye and Scherrer X-ray spectrometer, and extensive reference is made to the results of previous investigators and particularly Ono. The author has investigated the shear phenomena of metals of the cubical system, and particularly of pure aluminium. Previous work in this connection is extensively mentioned, and the author concludes by giving in tabular form his experimental results with very many spectrographic photographs by both the Laue and the Debye-Scherrer methods. B. J. L.

100. *Reflection of X-Rays from the Fluorite Crystal.* **M. Yamada.** (Tôhoku Univ., Sci. Reports, 11. pp. 447–450, Dec., 1922. In English. Sixty-ninth Report of the Iron and Steel Research Inst.)—In an investigation on the reflection of X-rays by fluorite, Pealing [Abstract 138 (1922)] found that the third order reflection from the (100) plane which should vanish owing to the alternating layers of calcium and of fluorine atoms is stronger than the first order reflection. This fact was considered as confirmation of the Lewis-Langmuir theory of the displacement of valency electrons in the compound. The present author shows that the abnormality can be explained without the aid of this theory. It is shown that with increasing glancing angle the power of the X-ray reflection of fluorine atoms decreases more rapidly than in the case of the calcium atoms. In the (100) plane of fluorite the alternate planes Ca and F have nearly equal surface density, and their reflecting power must be approximately the same so that odd order spectra should vanish. Owing to the fact that the reflecting power of the F layer decreases more rapidly than that of the Ca layer with increasing glancing angle, the balance is destroyed, with the result that odd order spectra can appear in the higher order reflections. By tracing the relation between the glancing angle and the reflecting power of the planes, it is shown that a maximum of intensity occurs at $\theta = 38°$ or nearly the angle of the third order spectrum. In arriving at these results a plane ring distribution of electrons in the atom is assumed but no correction is made for the orientation of atoms in each of the atom groups. It is pointed out that the same result would be obtained if it were assumed that the electrons were distributed in spherical shells.

The calculated value of the intensity of the third order reflection is larger than the experimental value. It is suggested that this may be due to the effect of thermal vibration of the atoms which would tend to diminish the intensity of X-ray reflection at large glancing angles.

E. A. O.

101. *Low-velocity X-Ray Electrons.* **L. Simons.** (Phil. Mag. 46. pp. 473–480, Sept., 1923.)—Whilst studying the absorption of X-ray electrons in various gases certain peculiarities in the absorption curves led the author to conclude that groups of electrons, as predicted by O. W. Richardson, possessing speeds less than that given by the equation $\frac{1}{2}mv^2 = h\nu$ where ν is the maximum frequency of the incident radiation, played an important rôle in electronic emission. Further work on the subject by the writer [(see Abstract 880 (1921)] and by de Broglie and by Whiddington showed conclusively that the maximum speed of each sub-group could be represented by the equation $\frac{1}{2}mv^2 = h(\nu - \nu_0)$ where ν_0 represents the frequency of the radiation associated with the level within the atom from which the electron is ejected, the value of which is determined from a knowledge of the X-ray spectrum of the element emitting the electrons. The validity of this equation has been confirmed in the region of γ-ray frequencies by Ellis [see Abstract 1638 (1922)]. In the present experiments a retarding electrostatic field method is employed, such as is described by Richardson and Brown in their study of the distribution of the normal component of the velocity of thermions emitted from a comparatively small surface of hot platinum towards an extensive plane opposite. In the corresponding X-ray experiment the electronic currents measured were necessarily much smaller and, moreover, no variation of the opposing electrostatic field, caused, for example, by the charging of an electrometer, could be allowed for during a run. A "null" method of employing a tilted electroscope was therefore devised and other precautions employed that are also described. Diagrams of the apparatus used are given. It is shown that the normal component of the velocity of over 85 per cent. of the electrons emitted from a gold film under the influence of a heterogeneous beam of X-rays is less than 2 volts. The distribution with velocity bears a relationship to that of the thermions from a hot body. It is argued that the mode of production of these slow electrons can scarcely be due to atomic recoil consequent on the ejection of a rapid β-ray nor to the action of the transformed X-ray energy into energy of longer wave-length. The analogy with the thermionic process probably arises from the fact that in both cases only the outermost system of electrons take part in the action, though the mechanism of the two processes must differ considerably, in the present case the intermediary being the rapid primary β-ray. The distribution with velocity of the electron atmosphere, from the point of view of thermionics in the case investigated, corresponds to a temperature of 11,000° abs. The importance of investigating, under all conditions, the correspondence between the two processes is therefore urged. A. E. G.

RADIO-ACTIVITY.

102. *Chemical Action of Radium Rays.* **A. Kailan.** (Akad. Wiss. Wien, Ber. 130. 2a. No. 6. pp. 317–328, 1921.)—Tests of actions and secondary reactions. The effect is, *cæteris paribus*, several hundred times smaller than that of a mercury lamp. A. D.

103. *Scattering of X- and γ-Rays by Rings of Electrons. Effect of Damping of the Incident Radiation.* **G. A. Schott.** (Roy. Soc., Proc. 104. pp. 153–164, Aug. 1, 1923.)—Could damping of the incident radiation account for the abnormally small scattering of hard γ-rays by aluminium, iron and lead observed by Ishimo? Mathematical investigation. The answer is in the negative. A. D.

104. *Penetration of Radium Emanation Nuclei.* **E. Rie.** (Akad. Wiss. Wien, Ber. 130. 2a. No. 6. pp. 293–299, 1921.)—The average depth of penetration in electrolytically deposited copper or nickel is 10 $\mu\mu$. A. D.

105. *The γ-Rays of Uranium X Ascribed to Uranium X_1 and Uranium U_2.* **O. Hahn** and **L. Meitner.** (Zeits. f. Physik, 17. 3. pp. 157–167, 1923.)—Meitner has shown that the analysis of the β-ray spectrum of UX_1 leads to the assumption that this substance emits no nuclear γ-radiation, and that what is measured as γ-radiation is the characteristic X-radiation, particularly that from the K level of the UX_1 atom, which is identical with that of its isotope thorium. To confirm this accurate absorption curves of the γ-rays of UX ($UX_1 + UX_2$)

have been obtained by the authors, and a division of the separate γ-ray groups between UX_1 and UX_2 has been attempted. The logarithms of the activity, as measured by an electroscope, after passing through different thicknesses of lead, were plotted against the thickness of the absorbing layer; and by a graphical process of analysis, assuming that for each kind of γ-ray present the intensity diminished exponentially in passing through the lead, the total γ-radiation was analysed into three different groups, the constants of which were determined. The group of mean hardness was identified with one measured by Soddy and Russell by absorption in aluminium; Richardson wrongly supposed it to be the most penetrating γ-radiation of UX. By a suitable method of chemical separation it was possible to assign the γ-ray groups to the substances UX_1 and UX_2, and it was thus proved that UX_1 has no penetrating, nuclear, γ-radiation, but only emits the characteristic X-rays from the K and L levels; the L-radiation was not observed by the authors, but has been found by Richardson by another method. The two groups of penetrating nuclear γ-rays belong to UX_2. H. N. A.

106. *Becquerel Rays and Photographic Plates.* **K. Przibram.** (Akad. Wiss. Wien, Ber. 130. 2*a*. No. 6. pp. 271–277, 1921.)—Confirms E. Mühlestein's results that α-rays pit the gelatine and produce solarisation and, in addition, finds blackening. The same results are caused by β- and γ-rays. The differences consist in the proportion of energy absorbed expended in producing these effects. A. D.

107. *Distribution of Lengths of Rays.* **Irène Curie.** (J. de Physique et le Radium, 4. pp. 170–184, May, 1923.)—The lengths of α-rays from polonium are distributed according to a probability law, except the shortest, which are in excess. The most probable length in air is 3·85 cms. at 15° C. and 760 mm. The law of probability is the same as that theoretically deduced by Bohr [Abstract 1720 (1915)]. Bragg's supposition confirmed, that the ionising power of the individual α-rays passes through a maximum shortly before the end of the course and then falls off rapidly. Divers interpretations are suggested for the behaviour of those rays whose course is short. A. D.

108. *Relations between Radio-activity, Temperature and Sulphuration of Springs in Bagnères-de-Luchon. Explanatory Hypothesis.* **A. Lepape.** (Comptes Rendus, 176. pp. 1908–1910, June 25, 1923.)—The waters of about thirty springs in the vicinity of Bagnères-de-Luchon have been analysed for their sulphur and radium content. The following conclusions are drawn from the analysis: (1) Springs which emerge from schists are less radio-active than those which have their origin in granite; (2) generally, the lower the temperature, the greater the radio-activity; (3) the sulphur content generally increases with the temperature; (4) for some of the springs examined, the radio-activity varies inversely as the temperature and the sulphuration; for others the radio-activity appears to vary inversely as the temperature and directly as the sulphuration. The observations show that there are two kinds of spring water in the district surveyed: (*a*) that from a depth having a high temperature and high sulphur content, but practically non-radio-active, and (*b*) that from the surface, either cold or tepid, containing no sulphur, but very radio-active. The existence of water which is sulphurous and radio-active is accounted for by the fact that the above two kinds of water have access to each other through fissures in the ground. E. A. O.

109. *Researches on the Constant of Polonium.* **S. Maracineanu.** (Comptes Rendus, 176. pp. 1879–1881, June 25, 1923.)—The values hitherto found for the period of polonium vary between wide limits, namely, 134·5 to 143 days. The cause of this variation has been tracked down by the author to the penetration of the polonium in the substance on which it is deposited. Eliminating this source of error, concordant results have been obtained, the half-value period (τ) being 139·5 days (and the radio-active constant (λ) $4 \cdot 96 \times 10^{-3}$ per day). This value agrees with the period 140 days found previously by Mme. Curie [see Abstract 527 (1906)]. In general, to obtain good results for the periods of radio-active substances, it is recommended that they be deposited on glass and not on metal plates. Heating and the use of large quantities should also be avoided. E. A. O.

110. *The Period of Protactinium.* **J. H. Mennie.** (Phil. Mag. 46. pp. 675–685, Oct., 1923.)—The period of protactinium was determined by comparison with that of ionium. The protactinium, and also the ionium, which had grown since 1909 in a large quantity of uranyl nitrate, purified in that year by Soddy, were separated, and their activities measured. Several different chemical processes were employed, the final method depending on the fact that ionium and its isotope UX are sparingly soluble in HF. The α-ray measurements were made in a special electroscope, designed to enable a small α-radiation to be measured in the presence of the intense β-radiation of UX; the preparations were placed in a small tray, below the electroscope, and separated from it by a very thin sheet of aluminium foil; on either side of the tube or box, at the bottom of which the tray was placed, were the poles of an electromagnet, by means of which the β-rays could be deflected, so that they could not enter the electrometer; a mica screen, just thick enough to cut off the α-rays without appreciably affecting the β- and γ-rays, could be moved across the opening into the electroscope, by means of a rack and pinion; the electroscope was filled with hydrogen; this has the effect of diminishing the ionisation due to the β- and γ-rays, and gives greater range to the α-rays. Instead of attempting to work with very thin layers of preparation, so as to avoid the effects of internal absorption, it was necessary, on account of the limited area available for the tray between the magnet poles, to use preparations of more than the limiting thickness, beyond which an increase of thickness does not affect the surface activity; and this surface activity multiplied by the weight of the preparation was taken as proportional to the total activity of the material; for the theoretical considerations involved the original paper should be consulted. The mean value obtained for the average life period of Pa, omitting one preliminary measurement, was 18,000 years, which corresponds to a half-value period of 12,500 years. Hahn and Meitner found 12,000 years as the mean of three determinations of the half-value period. H. N. A.

HEAT.

111. *Disappearance of the Filament and Diffraction Effects in Improved Forms of an Optical Pyrometer.* **C. O. Fairchild and W. H. Hoover.** (Optical Soc. of America, J. and Rev. Sci. Inst. 7. pp. 543–579, July, 1923.)—The precision, accuracy, and wide range of usefulness of the disappearing filament optical pyrometer depend on perfect disappearance of the filament with high resolving power and magnification by the eyepiece. Older forms have not accomplished this. Non-disappearance of the filament is caused by diffraction, and, if the filament is a wire, by reflection at its edges. Perfect disappearance of a flat filament with sharp edges is obtained by using an entrance aperture sufficiently large compared to the exit aperture. A round filament is made to disappear by decreasing the entrance aperture until diffraction and reflection nearly balance, in their effects at the filament.

An extensive study of diffraction revealed the fact that diffraction by an obstacle in an image plane is a special case which has not been previously recognised as such. It is shown that a new law of diffraction is consistent with theory and experiment, *viz.* of light incident on an obstacle in an image plane, only that component is diffracted which represents the diffracted rays radiating from the edge of the aperture. Thus with the flat filament there is no visible effect of diffraction if the aperture of the observing eyepiece (exit aperture) is far outside the shadow of the entrance aperture. Precise measurement shows that when the filament is made properly to disappear, the ratio of brightness of filament and image when an apparent match is obtained, is unity.

A laboratory form of the pyrometer is described, which has been used with success as a tele-pyrometer and as a micropyrometer. Two special improved forms of micropyrometer, or microphotometer are described in principle. [See Abstract 595 (1922).] E. G.

112. *Evaporation of Carbon.* **Wertenstein and Jedrzejewski.** (Comptes Rendus, 177. pp. 316–319, July 30, 1923.)—In order to ascertain whether the blackening of the bulb of an incandescence carbon filament lamp is due to evaporation or pulverisation of the filament, the authors have investigated the variation of the rate of evaporation of the filament with the temperature. After being heated to a definite temperature, the filament was weighed and its diameter measured microscopically. The blackening is found to be due to sublimation, the loss of carbon from the filament increasing rapidly and linearly between 2800° and 3500° abs., whereas for disintegration the temperature coefficient would be inappreciable. Confirmation of this conclusion is found in the fact that the sublimates formed over the above range of temperature are distinctly crystalline, the symmetry being trigonal. For the pressure of saturated carbon vapour the following expression is deduced : $\log p = 14 \cdot 87 - \frac{47{,}000}{\mathrm{T}} - 0 \cdot 75 \log \mathrm{T}$, p being in mm. of mercury. Extrapolation from this formula gives for the absolute boiling-point of carbon the value 5100°, which is appreciably higher than the temperature of the positive crater.

The atomic heat of sublimation of carbon, referred to the absolute zero, is 216,000 cals. T. H. P.

113. *The Thermal Conductivities of Metal Crystals. I. Bismuth.* **G. W. C. Kaye** and **J. K. Roberts.** (Roy. Soc., Proc. 104. pp. 98–114, Aug. 1, 1923.)—Previously all accurate measurements of the thermal conductivity of metals have been made on bars of heterogeneous structure. It was thought desirable to compare the values so obtained with the more fundamental ones given by single crystals. A "plate" apparatus has been used which makes it possible to measure thermal conductivities as high as 0·02 c.g.s. with an accuracy of about 1 %, using specimens 2 cm. by 1 cm. in area and about 1 or 2 mm. in thickness. The thermal conductivities of single crystals of metallic bismuth have been determined in directions parallel and perpendicular to the trigonal axis. The values found at 18° C. were in c.g.s. units:

Thermal conductivity of bismuth parallel to trigonal axis .... = 0·0152
Thermal conductivity of bismuth perpendicular to trigonal axis = 0·0221
Ratio of conductivities .... = 1·39

If a random distribution of crystals is assumed, these figures give a mean conductivity of 0·0195, which agrees well with the value 0·0193 obtained on bars by Jaeger and Diesselhorst in 1899. E. G.

114. *Tables and Diagrams for Water Vapour Computed on the Basis of its Specific Heat.* **O. Knoblauch, E. Raisch,** and **H. Hausen.** (Mech. Engineering, 45. pp. 538–540, Sept., 1923.)—Gives a diagram of the determinations of the specific heat of water made recently by Knoblauch and Raisch at the Munich Technical School. It is claimed that an equation for the specific heat, C_p, has been derived, of simple character, with pressure and temperature as magnitudes of the first power only. Two steam tables computed from the specific heat are shown.

W. N. Y. K.

115. *Relations Concerning the Internal Heat of Vaporisation.* **J. E. Mills** and **P. K. Smith.** (J. Phys. Chem. 27. pp. 301–321, April, 1923.)—The equation $\mu'\sqrt[3]{d} + \mathrm{CRT}\log v = \mu'\sqrt[3]{\mathrm{D}} + \mathrm{CRT}\log \mathrm{V}$ has been tested for twelve substances from 0° C. to the critical temperature and has been found to be a remarkably exact equation whenever $\mu'\sqrt[3]{\mathrm{D}}$ is greater than 3/2 RT. In the above, d is the density of the liquid, D that of the saturated vapour, T is the absolute temperature, v is the volume of one gramme of the liquid, V is the volume of one gramme of the saturated vapour, μ' and C are constants for any particular substance, and R is the gas constant. [See also Abstract 766 (1910).] E. G.

116. *The Differential Form of the Equation of State and its Application.* **V. Fischer.** (Ann. d. Physik, 71. 8. pp. 591–602, June 19, 1923.)—This is a continuation of previous work [see Abstract 1427 (1923)]. The author develops certain general equations and then uses Bridgman's experimental results (Am. Acad., Proc. 47. p. 432, Table xiii, and p. 539, Table xxxi, 1912) to test his results, and finds a partial agreement. The principal results obtained are $\mathrm{T}(\partial v/\partial \mathrm{T})_p = \mathrm{T}f(p) = v - \beta = v - f(p)$ .. (1); $\mathrm{T}(\partial p/\partial \mathrm{T})_v = \mathrm{T}f(v) = p + \pi$ .. (2); and $(v-\beta)/(p+\pi) = -(\partial v/\partial p)\mathrm{T}$ .. (3), which last equation becomes for a perfect gas $v/p = -(\partial v/\partial p)T$, since $\beta = \pi = 0$. No. (1) represents the equation to an isobar in the v, T diagram; (2) a line of constant volume in the p, T diagram; and (3) is the equation to an isothermal in the p, v diagram. A table of values of β and $\partial v/\partial T$ is then given calculated from Bridgman's results. Finally an integral form of the equation of state is obtained. Starting with the general equation $C_p - C_v = AT(\partial v/\partial T)_p(\partial p/\partial T)_v$, and using (1) and (2) above we get $T(C_p - C_v) = A(v - \beta)(p + \pi)$, or $T \, . \, \tau = A(v - \beta)(p + \pi)$ where τ is put for $C_p - C_v$. We can calculate τ directly from this equation if we have found β and π. We can, however, obtain the value of τ from Bridgman's results since by using the above general relation and the equation, $(\partial p/\partial v)_T(\partial v/\partial T)_p(\partial T/\partial p)_v = -1$, we get,

$$\tau = -AT \, . \, (\partial v/\partial T)^2_p/(\partial v/\partial p)_T.$$

For mercury τ is found to have a nearly constant value, $= 0 \cdot 0036$. For water τ has a maximum value at pressures between 5000 and 6000 atmospheres. T. B.

117. *The Equation of State for Pure Nitrogen, Gas Phase.* **L. B. Smith** and **R. S. Taylor.** (Am. Chem. Soc., J. 45. pp. 2107–2124, Sept., 1923.)—The constants for the equation of state for atmospheric nitrogen based on the data of Amagat have been published by Keyes. The purpose of the present paper is to provide accurate data from which the fundamental constants for pure nitrogen may be deduced. The nitrogen was prepared by heating a mixture of ammonium sulphate and potassium nitrite in solution. Extreme care was taken in the purification of the gas. The pressures obtained are lower at about 90 atm. by 0·6 % than those given by Holborn and Otto, but this was not found to be the case until the "pure" nitrogen chemically prepared had been fractionated to remove traces of nitric oxide. Over a range of temperatures from 0° to 200° C., and 30 to 330 atmospheres pressure, the data were well represented by the Keyes equation of state, $pv = RT \, . \, v/(v - \delta) - Av/(v + l)^2$ [see Abstracts 858 (1917), 351 (1922)]. The equation obtained for pure nitrogen is $p_{\text{atm.}} = 2 \cdot 92855T/(v - \delta) - 1623 \cdot 63/(v + 0 \cdot 2954)^2$, where $\log \delta = 0 \cdot 18683 - 0 \cdot 3113/v$. The weight of a litre of nitrogen at N.T.P. was calculated from the equation of state to be 1·2509 gm. as compared with the generally accepted value of 1·2507 gm. The compressibility coefficient at 0° is found to be 0·00061 as compared with 0·00056 from Holborn and Otto's equation and the work of Raleigh, and 0·00043 and 0·00044 from Chappuis and Maverick, respectively. Owing to the extreme accuracy with which an observer must work in order to obtain any percentage accuracy for this coefficient, the agreement is as good as can be expected. T. B.

118. *Melting-Point of Ice on the absolute Temperature Scale.* **L. B. Smith** and **R. S. Taylor.** (Am. Chem. Soc., J. 45. pp. 2124–2128, Sept., 1923.)—The expansion coefficient, ϵ, for a perfect gas has been calculated by Keyes [see Abstract 729 (1920)] using data from Chappuis, Day and Clement, and others, and the equation of state which he based on Amagat's data for atmospheric nitrogen. Since then Henning and Henning and Heuse have published work on expansion coefficients for nitrogen and other gases. The present authors have therefore reviewed the above data using their new equation of state of nitrogen (see preceding abstract), and also give the method of obtaining ϵ using the equation of state. Instead of a constant-pressure thermometer, a constant-π thermometer is considered where π is defined by the equation $\pi\omega = RT$. From the Keyes equation of state $\omega = v - \delta$ and $\pi = p + A/(v + l)^2$. Since $1/\epsilon = T_0$, the absolute temperature of melting ice can be calculated from the measured expansion coefficients. The mean value obtained is 273·12°, as compared with 273·14° by Keyes after a review of the data on coefficients of expansion for all gases for which data are available, and 273·13° by Buckingham. T. B.

119. *The Properties of Fluids in the Saturated State Near the Critical Point.* **J. E. Verschaffelt.** (J. de Physique et le Radium, 4. pp. 158–169, May, 1923.)—A mathematical paper in which the author shows how to deduce from the characteristic equation the properties in the saturated state near the critical point. This method consists in expressing the pressure in a series of powers of $v - v_c$ and $T - T_c$ in the neighbourhood of the critical point and then applying the principles of thermodynamics to this equation of state near the critical point. He applies this method to a particular equation of state to which he had been led by a study of the isothermals and the curve of saturation; this equation expresses the fact that each isothermal presents at a determined point (the critical isothermal at the critical point) an analytical discontinuity which observations in the neighbourhood of the critical point, unhappily only too few, appear to confirm. Of course, this analytical discontinuity in the direction of the isothermals, if real, is not in disagreement with the physical continuity of the liquid and gaseous states, which simply shows that all the homogeneous fluid states can be represented by only one characteristic equation. [See also Abstract 93 (1923).] E. G.

120. *An Old Fallacy Concerning the Heat Equilibrium of a Gas in a Gravitational Field.* **P. Ehrenfest.** (Zeits. f. Physik, 17. 6. pp. 421–422, 1923.)—The old fallacy that the mean kinetic energy of a molecule of a gas in a lower layer is greater than that of a molecule in an upper layer, although carefully disproved by Boltzmann in 1876 [see Abstract 2095 (1909)], has cropped up again [see Abstract 1785 (1923)]. That this assertion is false is well known from the kinetic theory of gases. A simple proof may be desirable, and this is given by the author in the present note. T. B.

SOUND.

121. *High-Frequency Vibrations and Young's Modulus for Metal Bars.* **R. J. Lang.** (Roy. Soc. Canada, Trans. 16. Sect. 3. pp. 163–173, 1922.)—Describes an adaptation of Kundt's dust tube for obtaining the Young's modulus of a metal bar. The bar is of larger diameter than the glass tube containing the lycopodium and is placed with one end very near the open end of the glass tube. The bar is clamped at the middle and is struck with a hammer at the end remote from the tube. A single blow often produces the figures. E. H. B.

122. *Theory of the Singing Flame.* **E. G. Richardson.** (Phys. Soc., Proc. 35. pp. 47–54, Feb., 1923.)—Various theories of the action of the singing flame put forward since its discovery are reviewed and experiments to test the relative merits of the two most recent theories are described. A König manometric capsule is attached to the outer air tube on a level with the vibrating flame and this manometric flame is viewed simultaneously with the singing flame through a stroboscope. The two flames vibrate in the same phase. This is contrary to Gill's form of the older theory which requires that each phase of maximum pressure in the air tube should force the flame down or temporarily stop the flow of gas. Photographs, taken through the stroboscopic disc by rotating the camera during exposure, are given. Lord Rayleigh's theory is shown to fit the results most closely in that (1) heat is given by the flame to the air in the tube at each condensation, and (2) stationary waves are formed in the gas as well as in the air tube, but the lengths of gas tube favourable to singing cover a much wider range than that given by Rayleigh. The stationary waves are found by attaching a manometric capsule to various parts of the gas tube itself. In the same way, for certain lengths of gas tube, the author shows that there are no marked nodes, the gas shows forced vibrations but no resonance. Also a similar method is used to prove that when the flame sinks back to the jet the pressure of the gas inside the jet momentarily increases, *i.e.* the air outside and the gas inside the jet are in opposite phase in regard to pressure. T. H.

123. *Speed of Sound in N_2O_4. Lower Limit for Speed of Dissociation.* **E. Grüneisen** and **E. Goens.** (Ann. d. Physik, 72. 3. pp. 193–220, Aug. 7, 1923. From the Reichsanstalt.)—The speed of sound in N_2O_4 has been measured at various pressures and temperatures by the Thiesen method of closed cylindrical resonators. This shows that up to frequencies of the order of 15,000 per sec. there is no indication that the speed of sound depends on the frequency, as would be the case according to theory, if the dissociation time were comparable with the period of the sound. On the contrary, the absolute value of the speed of sound agrees well with the assumption that the dissociation period is *small* compared with the period of the sound. It is concluded from the best work at 25° C. and 760 mm. that the speed constant of dissociation (k) is certainly greater than 10,000, and that consequently in about 10^{-4} of a second each N_2O_4 molecule, on the average, dissociates at least once. E. H. B.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS AND ATMOSPHERIC ELECTRICITY.

124. *Exploration of Electrostatic Fields.* **N. Semenoff** and **A. Walther.** (Zeits. f. Physik, 17. 1. pp. 67–72, 1923.)—A method based on the use of a sound with a small glowing platinum wire. This wire liberates ions of one kind or the other or both according to circumstances until the potentials are equalised; then an equal number of ions of each kind is liberated. Application to fields of complicated form, such as those traversed by gratings. A. D.

125. *Graphical Determination of Magnetic Fields.* **T. Lehmann.** (Rev. Gén. d'Él. 11. pp. 347–357, Sept. 15, and pp. 395–403, Sept. 22, 1923.)—The author deals with the following problems: (1) Determination of the field in open or closed notches when the teeth are strongly saturated; (2) The properties of orthogonal prolongations of the level lines towards the interior of rotational fields; (3) Proof of the proposition that to every portion of a line integral in a magnetic field there corresponds a definite proportion of a section of the magnetomotive coil; (4) The graphic representation of inducing and induced rotational fields; (5) Proof that, contrary to the assumption hitherto accepted, reaction dynamo fields approach a maximum, not a minimum value in the neutral zone; (6) Determination of the field in a conductor in which Foucault currents are present.

The method followed is derived from Gauss's analytical dissection of a surface into infinitesimal squares, or rectangles, by means of two families of mutually orthogonal curves. The author follows O. Bonnet in calling the network formed by two such systems an isometric network. In an irrotational field div $\mathbf{H} = 0$ and curl $\mathbf{H} = 0$, so that the field admits of a non-uniform scalar potential and a family of equipotential, or level, surfaces. Now in a plane, to any harmonic function v satisfying the equation $\Delta v = 0$, there corresponds a conjugate function ϕ, related to v by the equations $\partial v/\partial x = \partial \phi/\partial y$ and $\partial v/\partial y = -\partial \phi/\partial x$, and the two families of curves intersect each other at right angles. Hence the difference in the values of ϕ at any two points measures the flux between the points. This was applied to the mapping of an electric field by A. Poitier in 1889, and later to the mapping of magnetic fields. If from the two families of curves $v =$ constant, $\phi =$ constant, we select the two sets $v = c,\ c + \Delta c,\ c + 2\Delta c\ \ldots$ and $\phi = c',\ c' + \Delta c',\ c' + 2\Delta c'\ \ldots$ we shall obtain a network of "curved squares," each of which represents a tube of unit reluctance.

In the case of rotational motion, the problem becomes more complex, the vectorial equations being div $\mathbf{H} = 0$ and curl $\mathbf{H} = 4\pi i$, where i is the electric current density. The existence of the requisite families of curves is then subject to the condition that ($\mathbf{H}$, curl $\mathbf{H}$) $= 0$, or $\mathbf{H} = \lambda$ grad ψ, λ and ψ being scalar quantities. But for commercial frequencies, the conduction current alone enters into consideration; and for this the vectors $\mathbf{i}$ and $\mathbf{H}$ are perpendicular to each other, so that $(\mathbf{H}, \mathbf{i}) = 0$; and since curl $\mathbf{H} = 4\pi\mathbf{i}$, we have $(\mathbf{H}, \text{curl } \mathbf{H}) = 0$. For the graphic solution of rotational fields, the author considers that it would be well to extend to them the concepts of magnetomotive force and magnetic reluctance and to introduce for this purpose the orthogonal curves into the rotational lines of flux. The curves referred to as gradients extend the equipotential lines of an irrotational field in the direction of the rotational ramifications, and delimit the "magnetomotive area" and the "rotational tubes." By means of the gradients, plane rotational fields, even with variable rotation, could be determined graphically without calculation. Twenty-seven diagrams are given. G. W. DE T.

126. *Capacity Machines.* **F. Ollendorff.** (Archiv f. Elektrot. 12. pp. 297–319, June 30, 1923.)—The author employs the fundamental equations of electrodynamics in the treatment of influence machines, or, as he proposes to call them, capacity machines. It is shown that it is possible to construct capacity machines, along the numerous different lines made use of in induction machines; and, in addition to generators, the paper deals with the theory of current-voltage transformers or converters, of synchronous machines, of the capacity commutator, of different connections in the c.c. capacity generator, corresponding to shunt and series field winding in an ordinary dynamo, of alternating current commutator motors, and gives a comparison between capacity machines and inductive machines. Taking one of the armature plates, and imagining an enveloping surface round it, the flux of the electric field intensity through the envelope is Φ, F is the envelope, df a surface element of the envelope, i the current per unit area through any portion of the envelope; and it is shown that $-d\Phi/dt = \int_{F}(idf)$. The expression $-d\Phi/dt$ is called the electrical "*Schwund*" or extinction, and the above equation may be expressed as follows: the envelope current is equal to the electrical extinction. Consider four nearly semicircular discs, mounted perpendicular to a common axis, so that a and a', the exciter discs, are insulated from one another, and form one circular disc, while b and b', the armature discs, form another; the potential difference between a and a' is E_a, while in the first instance the potential of b and b' is zero. Some lines of force pass from a, which is positive, to a' which is negative; and $\Phi_a = C_aE_a$, where C_a is the capacity of $a\,a'$. Plate b, which is supposed to be opposite a at first, is negative, and there is a flux Φ_b from a to b; the idea of a *Gegenkapazitat*, or counter capacity, between these plates is introduced; this equals D, and $\Phi_b = DE_a$; there is also a flux from b' to a'. If b and b' are joined by a wire of low resistance, the current in this wire, which is the current through the envelope of b, will be given by the equation $I_b = -d\Phi_b/dt = -d(DE_a)dt = -E_a dD/dt - D dE_a/dt$; or a part due to alteration of the counter capacity and one due to alteration of the exciting voltage. The counter capacity may be altered by rotating the armature disc with respect to the exciter disc, and the value of the counter capacity throughout the rotation can be calculated and plotted; thus the first step in a complicated mathematical treatment is obtained. H. N. A.

127. *Electrification Produced by the Pulverisation of Aqueous Solutions.* **J. J. Nolan** and **H. V. Gill.** (Phil. Mag. 46. pp. 225–244, Aug., 1923.)—The method of working is as described in a previous paper [see Abstract

2436 (1922)] devoted to the study of the effects obtained with mixtures of distilled water and tap water. In the present work special attention is given to the effects of substances occurring in rain water. It is found that, with the exception of NaCl, such substances do not appreciably diminish the charge produced when a rain-drop is broken in air. Non-electrolytes do not affect the development of charge. A group of substances shown by Lewis to give abnormal adsorption effects includes sodium oleate, methylene blue, congo red, and methyl orange, whose behaviour differs remarkably from that of the ordinary inorganic salts. In the case of methylene blue, 0·5 gramme per 10^6 c.c. of water is sufficient to reduce the positive charge to zero. The negative charge has a sharp maximum at 2·5 g. per 10^6 c.c., and the charge again becomes positive at about 11 g. per 10^6 c.c. It is suggested that certain results on inorganic salts obtained by other observers are due to the presence of impurities. A. B. C. L.

DISCHARGE AND OSCILLATIONS.

128. *Two Photographic Methods of Studying High-Voltage Discharges.* **K. B. McEachron.** (Am. I.E.E., J. 42. pp. 1045–1050, Oct., 1923.)—The author gives in this paper some results of an investigation on the variation in alternating current corona discharges with time. Two methods have been used. In the first method the discharging point is mounted at right angles to an insulated extension of the shaft of the alternator used to supply the h.t. transformer. This needle point is thus revolved synchronously with the supply and projects just within a porcelain tube, the outer surface of which is covered with tinfoil and earthed. Photographs of the corona discharge from the point to the tube have been taken at various voltages and frequencies, the form of the corona during the cycle being shown in a polar diagram. The brush discharge from the needle when positive and the slight glow when negative are well shown; the presence of a dark space between the needle and the brush discharge, when the needle is positive, is also pointed out.

In the second method the discharge occurs between two horizontal, stationary needle points. Photographs showing the form of the discharge in rectangular coordinates are taken with the aid of a special camera and revolving mirrors operated in synchronism with the supply alternator. The results confirm those found by the revolving needle method. In addition, the influence of a sheet of solid insulation interposed between the needles and of the shape of the discharge electrodes has been investigated. Photographs of sparks between the electrodes are also given. In general it is shown that the appearance of the positive brush is considerably influenced by changes in the circuit conditions. Further experiments are to be made to test the effects of different gases at varying pressures on the form of the discharge, quartz lenses being used in the camera. B. H.

129. *The Electrical Strength of Air between Plate Electrodes.* **H. Zipp.** (Archiv f. Elektrot. 12. pp. 319–330, June 30, 1923.)—The results of W. O. Schumann indicates that, for distances up to 11 cm., there is no fixed value for the breakdown field intensity calculated from the equation $E = V/d$, where V is the difference of potential between the plates, and d is the distance between them. This is due to the fact that the lines of force between the plates, even at the centre, are not equidistant parallel straight lines, but diverge outwards. The author investigates this divergence experimentally for the stream lines of electric current between electrode plates immersed in an electrolyte, using an alternating current and a pair of probe electrodes, with a constant small distance between them, by means of which the difference of voltage Δe could be measured, caused by this distance, at different points between the plates; he also makes a rough mathematical estimate of the effect of the divergence of the lines of flow; and, transferring his results to the lines of force in the actual problem under discussion, finds that V/d must be multiplied by a factor, which depends on the size of the plate electrodes and the distance between them, to obtain the maximum value of the field intensity in each case. Schumann's curves, thus corrected, point to the value 29,000 to 29,500 volts per centimetre for the electrical strength of air. The diminution of the dielectric strength of solid insulators with increased thickness, found by all observers except Schwaiger, may be due to the divergence of the lines of force. H. N. A.

130. *Electrical Discharges in Geissler Tubes with Hot Kathodes.* **W. H. McCurdy.** (Phil. Mag. 46. pp. 524–533, Sept., 1923.)—Duffendack has recently reported [see Abstract 163 (1923)] results obtained from work on low-voltage arcs, stimulated by the emission from a hot kathode, in diatomic gases. As his work dealt only with the arc characteristics, it was thought possible that additional light might be thrown on the process of ionization by a study of the discharge in Geissler tubes, if a hot filament were used as kathode to stimulate the discharge. This eliminates the uncertainty as to the source of the electrons which produced the ionisation in the tube, and, at the same time, overcomes the very high kathode fall of potential encountered in cold electrode tubes. A diagram showing the apparatus used is given. The experiments are described under the following heads:—(1) Relation between current through the tube and potential applied to the tube; also observations on the appearance of the discharge under various conditions. (2) Relations existing between the filament temperature pressure of the gas, and the least voltage (V_m) necessary to maintain the discharge in hydrogen. (3) Observations on V_m in mercury vapour. It is found that in Geissler tubes fitted with hot kathodes there are two discontinuous changes in the current as the voltage across the tube is increased, these changes being associated with the appearance of two types of luminous discharge. At short distances between the electrodes, however, one of these disappears, and the conditions of the low-voltage arc, stimulated by the emission from a hot kathode, appears. The behaviour of the two types of discharge under various changes in conditions is not the same, although the spectra appears to differ only in intensity. The least voltage at which it is possible to maintain a discharge under the condition here described is not found to bear any simple relation to the ionising potential of hydrogen, and a reason for this is offered. The voltages at which discontinuous changes in the current with mercury vapour occur are found to be multiples of the ionisation potential, or these multiples plus the first radiating potential. A. E. G.

131. *Passage of Kathode Rays through Matter.* **B. F. J. Schonland.** (Roy. Soc., Proc. 104. pp. 235–247, Sept. 1, 1923.)—The experimental arrangement is founded upon that of Whiddington and a diagrammatic sketch and full details are here given. Secondary rays are first considered and the means of preventing these from upsetting the measurements described. The variations of absorption with velocity are dealt with under two heads, (1) apparent absorption, (2) true absorption, and the variations of absorption with thickness is similarly treated. In the variation of range with the nature of absorbing material a table is given showing results obtained with aluminium, copper, silver, and gold with 28,500 volts, 23,600 volts, and 18,500 volts. The absorption of kathode rays of velocity $6\cdot0 \times 10^9$ to $1\cdot2 \times 10^{10}$ cm./sec. in these metals has been studied with an arrangement to measure both the fraction of the beam passed through and that actually absorbed in the foil. The latter fraction is found to vary with thickness and velocity in the same manner for all elements; the nature of the variation of the former fraction depends upon the absorbing material. The conception of a range for these particles is established by two independent methods of measurements. The results are explained by applying the theory of absorption due to Bohr, with which they are by quantitative agreement. A. E. G.

132. *Recombination of the Natural Ions in Air; Weak Atmospheric Ionisation.* **A. D. Power.** (Frank. Inst., J. 196. pp. 327–352, Sept., 1923.)—The coefficient of recombination of ions in air was determined for "natural" ionisation as opposed to the strong "artificial" ionisation usually used. McClung's method was replaced by a new method requiring the measurement of the growth with time of the number of ions per cm.^{3}. The diffusion correction is based upon a solution obtained for $\partial n/\partial t = D(\partial^2 x/\partial t^2) - \beta n + q$. Results substantiate von Schweidler, that for natural ionisation it is more appropriate to use a βn than an αn^2 term; this is here extended to confined air under α- and β-rays. The value of β is on the average 6×10^{-3}, even when the dust content is very low. Its use cannot, therefore, depend upon the presence of dust: but in any event a very small quantity of dust would explain it. Under natural ionisation the distribution of ions appears to be non-uniform, confined to non-overlapping columns. For low potentials, the capacity of an air-condenser with plates, say, 20 cm. apart may be increased by the factor 2·7 by natural ionisation. If the plates of a closed condenser be momentarily earthed they will in the final state be at zero potential, no matter what the original distribution of ions may be. A. D.

133. *Motion of Electrons in Gases under Crossed Electric and Magnetic Fields.* **R. N. Chaudhuri.** (Phil. Mag. 46. pp. 461–472, Sept., 1923.) —Experiments carried out on the lines of previous research [see Abstract 1203 (1923)] are described in which special study is made of the two gases A and CO. It is found that when electrons are moving through any gas the current between the emitting source and the anode is not stopped by a magnetic field (large enough to stop the current in vacuum) acting perpendicular to the electric intensity. In argon the residual current is very small, whereas in CO the fraction is fairly large: *e.g.*, at 100×10^{-4} mm. pressure the percentage in A is 0·1, whilst in CO it is 13·3. When the velocity of the impinging electron is increased, the percentage of the residual current does not increase, at least up to the ionisation potential of the gas (CO). Above that potential the percentage of residual current increases. On the assumption that the residual current is due to the electrons colliding several times with gas molecules, an expression is developed for the mean free path of the electron, the value found for CO agreeing fairly well with that deduced from kinetic theory: with argon, an abnormally large free path is observed, the value obtained being more than 10 times that calculated from kinetic theory. A. B. C. L.

134. *Photoelectric Currents.* **W. Schottky.** (Phys. Zeits. 24. pp. 350–352, Aug. 15, 1923.)—The author replies to Dällenbach and Jahn [Abstract 1938 (1923)], and supports the views of Schenkel and Schottky on the high value of certain photoelectric currents. J. J. S.

135. *Motion of Electrons in Helium.* **J. S. Townsend** and **V. A. Bailey.** (Phil. Mag. 46. pp. 657–664, Oct., 1923.)—Previous communications have dealt [see Abstract 2310 (1922)] with a method of determining the motion of electrons in various gases, and the present paper applies this process to determine the motion in helium. The experimental part of the investigation consists in determining the velocity of a stream of electrons in the direction of a uniform electric force and the velocity of agitation. For this purpose it has been found convenient to use two instruments, one suitable for the measurement of the velocities in gases where the stream of electrons has a moderate lateral diffusion, and the other suitable for gases like argon where the lateral diffusion of the stream is very large. A description of these instruments is given in published researches on argon and hydrogen [see Abstract 354 (1923)]. Two specimens of helium were used, one from a natural source and the other from thorianite. The velocities of the electrons were found to be almost exactly the same in the two specimens. Tables of results are given, and comparison curves included for the mean free paths in hydrogen and helium. In helium the mean free path is nearly constant for velocities between 10^8 and 5×10^7 cms. per sec., and the increase in the free path as the velocity diminishes occurs for smaller velocities in helium than in argon. H. H. Ho.

136. *The Motion of Electrons in Carbon Monoxide, Nitrous Oxide, and Nitric Oxide.* **M. F. Skinker** and **J. V. White.** (Phil. Mag. 46. pp. 630–637, Oct., 1923.)—An account has already been given [see Abstract 353 (1923)] of the motion of electrons in carbon dioxide, and the present investigation now applies the methods described previously to obtain data for carbon monoxide, nitrous oxide, and nitric oxide. From theoretical considerations the velocities of electrons are functions of the ratio electric force Z/gas pressure p, but when electrons tend to form ions by adhering to molecules of the gas the velocities of ions and electrons are found experimentally to diminish as the pressure increases. The authors have found that in CO as in CO_2, the electrons do not tend to form ions, but in NO ions are formed, and, as in the case of oxygen, this effect is most noticeable with the smaller values of the above ratio Z/p. With N_2O a different result was obtained, however, since for the smaller values of Z/p the velocities are, within experimental error, functions of Z/p, and by a direct method of testing for the presence of ions it was found that there were very few ions in the stream. For the larger values of Z/p the velocities are not functions of this ratio, and by the direct method of testing a large number of ions were found in the stream. This direct method consists in observing the effect of a magnetic field on the charges acquired by the receiving electrodes of the stream of electrons passing through a gas. The paper is replete with data and illustrative curves.

H. H. Ho.

137. *Forced Oscillations in Self-maintained Oscillating Circuits.* **W. A. Leyshon.** (Phil. Mag. 46. pp. 686–698, Oct., 1923.)—The present paper is concerned with the behaviour of certain electrical circuits maintained in oscillation by a 3-electrode thermionic tube, or triode, under the influence of impressed oscillations. An alternating voltage was applied to an oscillating triode system, either by means of a second triode system, which was itself acted on by the first system, or by means of a circuit, (possessing constant amplitude and frequency) maintained by a tuning-fork and 2 triodes in parallel. Low frequency oscillating circuits were employed, and the required phase differences shown by means of a Lissajous instrument designed for the purpose and fully described together with the other experimental details. The experiments on the accordant state suggest generally that when an alternating voltage of constant frequency and amplitude is applied to the grid of an oscillating triode, this voltage not differing markedly in frequency from that of the undisturbed oscillating system, the latter may be pulled into tune with the according voltage if the latter is sufficiently great. The phase difference between the grid voltage as supplied by the oscillating triode and the according voltage in the accordant state depends on the strength of the latter, and on the difference in the frequency of the system supplying the according voltage and the undisturbed frequency of the triode system. When the according voltage is not sufficiently strong to pull the triode system into tune, modified beats are observed, the rate of change of phase with time being least when the phase difference is such that the triode system is most nearly in tune with the applied voltage. Only one-quarter of a cycle of phase change has been observed in the accordant state with comparatively strong according voltages. When an alternating voltage supplied by a triode system is applied to a second triode system, which itself affects the first system, half a cycle of phase change has been observed to take place between corresponding currents in the 2 triode systems.

H. H. Ho.

138. *The Propagation of Electric Waves in a Straight Metallic Wire Provided with a Conducting Cover.* **K. Försterling.** (Ann. d. Physik, 72. 1. pp. 30–57, July 20, 1923.)—A rigid theory dealing with Trautmann's results [see Abstract 2493 (1923)] on the high-frequency resistance of straight wires provided with conducting covers, should be capable of derivation from Maxwell's equations and the boundary conditions at the surface of cylindrical conductors. If it be possible also to state the solution by means of Bessel functions [see Harms, Abstract 1184 (1907)] then no serious physical difficulties arise. In the present paper a similar procedure is adopted to that employed by Abraham for evaluation of the skin effect of high-frequency currents in a simple wire, who had in this case to deal with *e* functions. Under the assumption that the electric waves only penetrate slightly into the conductor, their propagation in metallic wires with conducting covers may be treated to a close approximation and the resistances evaluated with the aid of the Poynting complex vector. The cases are discussed in detail of a copper wire with iron cover, and a copper coated iron wire. In both cases theory demands the resistance to depend on the thickness of the coating, a circumstance in agreement with Trautmann's experimental observations. The case of a coppered iron wire is of great practical importance, and here both theory and experiment lead to the result that for certain thicknesses of the coating the resistance varies only slightly with the wave-length. H. H. Ho.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

139. *Photoelectric Emission from Insulators.* **P. Cardani.** (Accad. Lincei, Atti, 32. i. pp. 202–208, March 4, 1923.)—Light from a mercury lamp is allowed to fall on a plate of the material which has been charged by friction. In front of the specimen is a metallic grid which can be raised to a high potential with respect to another plate at the back of the specimen. Photoelectric emission is accompanied by ionisation of the gas in the apparatus and rapid dissipation of the charge. This is observed with an electrometer. The intensity of the effect is tabulated for ebonite, sulphur and pitch for various degrees of electrification. This last quantity is expressed as the number of strokes given the specimen with a woollen cloth. For high applied potentials, the increased ionisation current due to collisions is noted. A. Wh.

140. *Photoelectric Conductivity of Diamond.* **(Miss) M. Levi.** (Roy. Soc. Canada, Trans. 16. Sect. 3. pp. 241–256, 1922.)—Two diamonds examined. Considerable lag, both in growth and decay, of the photoelectric currents. The photoelectric sensitivity increases with decreasing wave-length of exciting light. Unidirectional conductivity found; dark currents investigated. On application of an electric field the diamonds become polarised and counter-fields develop within them. Gamma rays gave a photopositive reaction (resistance decreased on illumination) with the one diamond, a photonegative with the other. A. D.

141. *Photoelectricity.* **S. Timpanaro.** (Accad. Lincei, Atti, 32. i. pp. 225–227, March 4, 1923.)—Various simple experimental methods for demonstration purposes. A. D.

142. *Dielectric Constants and Pressure.* **F. Waibel.** (Ann. d. Physik, 72. 3. pp. 161–192, Aug. 7, 1923.)—In hexane, bisulphide of carbon and benzol from 1 kg. to 130 kg. per sq. cm., the dielectric constant follows a law $\epsilon = \epsilon_0(1 + ap + bp^2)$. An electron tube was used as an exciter of vibrations, and a vibration galvanometer as a resonance. A simple oscillation-method is given for comparing two capacities in the ratio of 1 : 100 or 100 : 1. A. D.

143. *Electric Polarisation of Dielectric.* **G. Jacoby.** (Ann. d. Physik, 72. 2. pp. 153–160, July 20, 1923.)—On the hypothesis that the polarisation of a dielectric depends upon displacements of polarisation electrons in the atom under quasi-elastic forces in the field proportional to the displacements, the author investigates these quasi-elastic forces from the point of view of the newer conceptions of the atom, and calculates the dielectric constants of sulphur and of water. A. D.

144. *Variation of Dielectric Constant with Frequency and Energy Loss in Standard Dielectrics.* **J. Mould.** (Beama, 62. pp. 337–344, June, 1923.)—The author investigates the variation of dielectric constant over a wider range of frequency (from 123 ∿ up to about 1,000,000 ∿) than hitherto attempted and measures the energy loss at various frequencies. Ebonite, glass, micanite, india-rubber, gutta-percha, xylonite and red fibre were examined. All showed a diminution of dielectric constant with increase of frequency, but the good dielectrics remain more constant. The variation of gutta-percha is more marked at the lower frequencies, while in the other dielectrics it is more marked at the higher frequencies. The energy loss was found to vary as some power of the electric force which is greater than the square. In good dielectrics the preponderating part of the energy loss is due to some property distinct from conductivity.

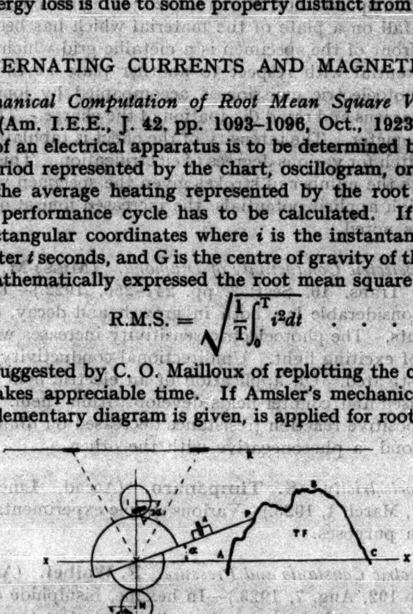
W. R. C.

ALTERNATING CURRENTS AND MAGNETISM.

145. *Mechanical Computation of Root Mean Square Values.* **L. A. Umansky.** (Am. I.E.E., J. 42, pp. 1093–1096, Oct., 1923.)—Whenever the capacity of an electrical apparatus is to be determined by the heating during the period represented by the chart, oscillogram, or plotted duty cycle curve, the average heating represented by the root mean square value of the performance cycle has to be calculated. If the curve is plotted in rectangular coordinates where i is the instantaneous value of the current after t seconds, and G is the centre of gravity of the elementary area, then mathematically expressed the root mean square is

$$\text{R.M.S.} = \sqrt{\frac{1}{T}\int_0^T i^2dt} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

The method suggested by C. O. Mailloux of replotting the chart in polar coordinates takes appreciable time. If Amsler's mechanical integrator, of which an elementary diagram is given, is applied for root mean square



calculation, the operation is much simplified, and considerable time saved. The readings on the three integrating discs A, M, I are taken before and after the point P has covered the whole curve ABCA. The readings on dial A give the area of the figure F; those on dial M the moment of the figure F about the axis XX; and the combination of the readings on dials A and I the moment of inertia of F about the same axis XX. The total moment determined by the integrator is

$$M = \tfrac{1}{2}\int_0^T i^2dt \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Hence by comparing expressions (1) and (2) we get

$$\text{R.M.S.} = \sqrt{2M/T}$$

so that the relation established between the root mean square of the duty cycle curve and the moment of the figure encircled by that curve about the line of abscissæ gives the answer to the problem. T. C. H.

146. *Nickel at the Curie Point.* **L. Tieri.** (Accad. Lincei, Atti, 32. i. pp. 280–282, March 18, 1923.—The Curie point is the same, 355°, for a nickel wire unstretched and stretched by a weight of 7 kg. The extension by the weight corresponds to a temperature difference of 21°. If the demagnetisation had been wholly due to separation of the elementary magnets in the nickel, it ought to have taken place at 334° in the stretched wire; but this is not the case. A. D.

147. *Magnetic Screen of Spirally Wound Iron Sheets.* **C. Benedicks.** (Ann. d. Physik, 72. 3. pp. 236–240, Aug. 7, 1923.)—W. Esmarch has shown the advantages of replacing a massive soft iron cylinder as magnetic screen by a series of soft iron cylinders separated by cardboard or other non-magnetic material [see Abstract 513 (1913)]. This suggested the use of a sheet of soft iron spirally wound with paper separating successive turns. The author finds that this method is preferable to the earlier one, effecting a further saving in the weight of the screen, while the manufacture is simplified. G. W. DE T.

148. *Atomic Moment of Oxygen.* **P. Weiss.** (J. de Physique et le Radium, 4. pp. 153–157, May, 1923.)—Reference is made to the work of Gerlach and Stern [see Abstract 2055 (1922)], and to that of Ehrenfest as regards the quantisation of the orientations of electronic orbits. In the new electronic theory, the molecular magnet is the quantity of matter which carries one electronic circuit productive of moment. Each atom of O_2 is therefore a carrier of one circuit, and in this case the molecular magnet is the atom itself. The molecular constant of Curie becomes $16 \times 0{\cdot}03158$, and this leads to the number of 10 magnetons per oxygen atom. G. E. A.

149. *Permeability and Hysteresis of Nickel.* **H. Pécheux.** (Rev. Gén. d'Él. 14. pp. 435–438, Sept. 29, 1923.)—Tests were made on three cylindrical bars of nickel, of given chemical composition, by means of a Carpentier torsion permeameter provided with an indicator of the magnetising field. The bars were first tested fresh, then after quenching, and finally after annealing, B, H curves being given. There are differences in the three bars which are not entirely explained by the chemical composition (total impurity, C, Si, and Fe about 2 per cent.). The curves for quenched nickel lie slightly above those for the untreated metal; quenching diminishes B_r and increases H_c. Annealin gimproves the permeability according to the amount of iron contained. The hysteresis losses were: In the fresh state, 4240; quenched, 4330; annealed, 4750 ergs. These losses (E) are expressed by means of a Steinmetz equation: $E = aB^x$, for which $x = 1{\cdot}503$, and a has the respective values $0{\cdot}068$, $0{\cdot}073$, and $0{\cdot}055$. [See Abstracts 1986 and 2516 (1923).] G. E. A.

150. *Relation between Iron Losses and the Maximum Induction.* **Jouaust and Miss Bourgoignon.** (Soc. Franç. Élect., Bull. 3. pp. 285–292, July, 1923.)—The losses in iron are generally expressed by means of Steinmetz's law: $W = \eta B^x$, where x has the value $1{\cdot}6$. The authors find that the index $1{\cdot}6$ does not hold in general. From certain past tests of sheet iron, for which η was greater than 0·002, the power 1·6 held good, but for another category for which η was less than 0·002, x required a value of from 1·85 to 2. Specimens of sheet iron from two different sources were tested at inductions of 10,000 and 14,000 the total losses being determined by means of an Epstein apparatus as modified by Armagnat. For these, the values of x required to give the loss at 14,000 from that at 10,000 were about 2 and 2·33 for the two categories. The authors refer to Yensen's experiments on silicon iron for which the value of x was 3·2; and they conclude that more experiments are necessary to clear up the point in question. G. E. A.

151. *On the Energy in the Magnetic Circuit of a Magneto.* **N. W. McLachlan.** (Phil. Mag. 46. pp. 337–364, Sept., 1923.)—The author has given a preliminary treatment of the subject in a previous paper [Abstract 891B (1920)], where zero loss was assumed, and it was supposed that the magnet always worked at a point upon the hysteresis quadrant, *i.e.* a variation in reluctance caused the working point to traverse the boundary line or the quadrant and not a subsidiary loop as it does in practice. In the present paper the problem is treated differently, and more crucially, with assumptions which are more in accord with practice; no restriction is placed on the shape of the armature; and it is shown that the optimum point for a magnet is not on the hysteresis loop at all, but on an auxiliary curve, which is associated with the locus of the intersection of subsidiary loops and armature reluctance curves; the value of B corresponding to this optimum point is not necessarily equal to that on the main quadrant, for which the product BH is a maximum. There is a temptation to show that a physical concept of the electromagnetic energy associated with the primary winding can be derived from the hysteresis quadrant, by imagining the magnet to be an elastic medium, which stores and restores the primary energy, *i.e.* a magnetic accumulator; as far as the present analysis goes there is no reason why the magnet and the primary should behave thus, and any changes in the magnet are due to changes of reluctance in the path of the magnetic flux through the magnet and its external circuit; these may be due to armature reaction, eddy currents, or variation in the configuration of the magnetic circuit; the energy concomitant with such variations is associated, through the medium of the armature, with the external source causing rotation. The theory is worked out in considerable detail, and applied to the determination of the optimum armature diameter, when magnet, air-gap and armature length are fixed, and of the optimum magnet, when armature, magnetic section, and air-gap are fixed; the effect of armature resistance is also considered at length. With an armature and magnet of prescribed dimensions, there is a certain air-gap, for which the electromagnetic energy in the primary circuit at break is a maximum. The optima values vary with the speed. At low speeds the air-gap should be as small as mechanically possible. Primary resistance should be small. H. N. A.

152. *Deformations of Liquid Streams Carrying Powerful Currents.* **L. Lombardi.** (Accad. Lincei, Atti, 32. i. pp. 467–473, May 6, 1923. Elettrotecnica, 10. pp. 665–668, Oct. 5, 1923.)—These are quite capable of being explained under the formulæ of Ampère and Neumann, without any of the assumptions invoked by Hering [Abstract 178 (1922)]. A. D.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

153. *Porosity of Nickel to Hydrogen Gas.* **V. Lombard.** (Comptes Rendus, 177. pp. 116–119, July 9, 1923.)—Two iron tubes were pressed against the opposite sides of a nickel disc 0·3 mm. thick, with copper washers interposed, and hydrogen was led along one pipe to the disc and drawn off, by means of a mercury fall pump, through the other. An electric furnace and Pt, Pt-Rd couple served for the thermal observations. The volume V of hydrogen at 0° and 760 mm. which traverses 1 sq. cm. of disc per hour at t° C. is given by the equation: $V = a^t$ where a is a constant. When the temperature is constant and the pressure P varies, the volume per sq. cm. per hour is given by $V = K\sqrt{P}$. At 700° and 770 mm. pressure the volume per sq. cm. per hour approaches 2 c.cm. G. E. A.

154. *The Curves of the Periodic Law. II.* **W. M. Thornton.** (Phil. Mag. 46. pp. 442–448, Sept., 1923.)—The rise and fall of the densities of the elements, plotted against the atomic weight, resemble the side elevation of a somewhat irregular spiral drawn on a transparent cone, the end elevation of such a curve of uniform angular pitch being a logarithmic spiral [see Abstracts 530 (1903) and 1182 (1917)]. The density curve exhibits minor fluctuations, the periods of which increase with the distance from the origin, but not so uniformly as they do on the cone spiral, where they are strictly proportional to it. Any regular periodic curve of this kind may be represented by a combination of harmonic curves chosen by inspection or analysis, and a fundamental curve of varying amplitude and period is given as a representation of that great periodic change in the configuration of the outer electrons in an atom under their own forces which a successful theory of atomic formation must explain.

On the fundamental curve is superposed one of double frequency which may be regarded as representing some form of retardation in the change of atomic volume of the nature of hysteresis, that is, a change of arrangement caused by the resultant force to which the fundamental is due, always occurring so as to produce the same deviation from the mean position in successive half-periods. The physical and chemical properties of the elements appear to depend as much on the minor periodic change as on the fundamental, and in order to bring out the differences between them curves are shown in which the ordinates are densities and the abscissæ projections of the major harmonic curve on the vertical axis. For the electric degradation theory of matter to be consistent, the increasing radio-activity from uranium to radium should be capable of explanation as a consequence of feebler control or of stronger force of expulsion. If the rate of change of density with atomic weight were such that the loss of the smallest possible unit of mass produced very great expansion of the remaining electric structure, the atom would be on the point of explosion and any increase in the rate would render it impossible for an atom to cohere. These points are illustrated by the curves shown. T. H. P.

155. *The Electron Theory of Chemistry. On the Changes in Chemical Properties produced by the Substitution of One Element or Radicle by*

Another, with Applications to Benzene Substitutions. **J. J. Thomson.** (Phil. Mag. 46. pp. 497–514, Sept., 1923.)—When a monovalent atom or radicle—such as F, Cl, Br, I, OH, CH_3, CN—is substituted for an atom of hydrogen, the number of electrons is increased; these additional electrons, together with the corresponding positive charges, change the electric field in and around the molecule. It is the object of this paper to investigate the nature of this change and the effect it might be expected to have on the chemical properties of the molecule. The first case discussed is that of replacement by halogens [see also Abstract 2088 (1923)], and it is shown that the molecule of CH_3Cl would have an electrostatic moment whose sign would be the same as that of an electric doublet with positive electricity on the carbon atom and negative on the chlorine. The magnitude of the moment would be e times the sum of the radii of the hydrogen and chlorine atoms; where e is the electronic charge, *i.e.* it would not differ much from the electric moment of a molecule of HCl. The cases of the replacement of H by OH and NH_2 are next examined. It is shown that whenever an atom or radicle is introduced which has no intrinsic moment such as F, Cl, Br, I, OH, NH_2, and which can receive an additional electron, *i.e.* one which contains an uncompleted octet, the effect will be represented by an electrostatic doublet whose negative end is on the side of the radicle and the positive end on the side of the molecule with which the radicle combines. The radicle CH_3 requires and receives special consideration, since in some cases the substitution of this for hydrogen seems to produce a change in the moment and not so in other cases. Substituents with a detached electron and a positive ion have a finite electrical moment, and the greater this moment the greater will be the distance of the positive ion from the 2 electrons which couple it to the molecule with which it combines. As examples of this type NO_2, COOH, CHO, and CN are considered. The author then interprets in terms of chemical properties the change of the electrical field due to substitution. Next comes a discussion of the polarisation of the double bond, and the consideration of the polarity of substituted benzenes, this concluding the paper. Benzene itself is a non-polar substance, which has a specific inductive capacity equal to the square of its refractive index, and, in the author's opinion, the introduction of a substituent by introducing an electrical moment, *i.e.* making the molecule polar, should therefore endow the molecule with a high inductive capacity; the difference between this specific inductive capacity and that of benzene should be a measure of the moment of the doublet representing the effect of substitution. Where measurements have been made, the substituted benzenes show, as a rule, very high specific inductive capacities. The author calculates that, where both substituents are alike, a para substitution destroys the moment and should therefore make the molecule non-polar and the dielectric capacity normal; meta leaves the moment unchanged in magnitude, and ortho increases the moment, thereby increasing the specific inductive capacity. It would therefore seem feasible that determinations of specific inductive capacity would be useful in such cases for finding whether the second substituent enters the para, meta, or ortho positions. Where the second substituent is not the same as the first, but of the same type, the specific inductive capacity will be least for the para position and greatest for the ortho, while that for the meta will be intermediate. If, however, the two substituents belong to different types, the specific inductivity capacity will be greatest in the para position and least in the ortho. H. H. Ho.

156. *Propagation of the Explosion Wave.* **P. Laffitte.** (Comptes Rendus, 177. pp. 178–180, July 16, 1923.)—An investigation is made with mixtures of carbon bisulphide and oxygen of the propagation of the explosion wave in all directions from a centre of emission. A photographic recording device is employed as in earlier experiments on the development of explosion waves in cylindrical glass tubes [Abstract 2318 (1923)]. The mixtures of gases are placed in spherical glass vessels of 15 to 22 cm. diameter. The light from the explosion passes through a horizontal slot to a photographic film attached to a cylinder which is arranged to rotate at a definite speed. In order to initiate an explosion in the centre of the vessel an explosion wave is admitted to the centre by means of a length of narrow tube leading from the outside to the centre of the vessel and containing the same gases. The photographs show that the moment the explosion wave, the velocity of which is estimated at 1800 metres per second, reaches the centre of the vessel, it is suddenly extinguished and replaced in the vessel by a feebler wave of combustion with a velocity of 450 metres per second. On reaching the walls of the vessel the wave is seen to be reflected and to proceed in the opposite direction and is again reflected several times until finally the vessel fractures without the explosion wave being set up. Observations were then made on detonating 1 gramme of fulminate of mercury in the centre of the gases. In this case, the explosion wave is generated immediately without any preliminary period of inflammation and is propagated equally in all directions with a velocity of 1800 metres per second. J. N. P.

157. *Application of Thermodynamical Principles to the Time Rates of Chemical Changes and Vaporisation.* **S. Sano.** (Japanese Journ. Phys. 1. 7–8. pp. 59–69, 1922. In English.)—A mathematical investigation of the extension of Guldberg and Waage's law of mass-action to the case of concentrated solutions by the use of chemical potentials. A. B. C. L.

158. *The Kinetic Theory of the Law of Osmotic Pressure in Strong Electrolytes.* **P. Debye.** (Phys. Zeits. 24. pp. 334–338, Aug. 15, 1923.)—The two laws (1) "Strong electrolytes are completely dissociated at all concentrations"; (2) "The observed deviations from the limiting laws (concentration = 0) can be explained as due to the electrical forces between ions and between ions and molecules of the solvent," may be considered as established. The author has obtained an expression for the lowering of the freezing-point which agrees with observation [see Abstract 2328 (1923)]. This was obtained from thermodynamical considerations. In a similar way the osmotic pressure and its connection with lowering of the melting-point can be deduced. On account of the importance of osmotic pressure it is advisable to obtain it solely from kinetic considerations, especially as this method allows escape from some of the difficulties in connection with the temperature coefficient of the dielectric constant of the solvent. This is therefore done, use being made of results previously obtained. The rest of the paper is divided into three sections. In the first is considered the case of a dissolved substance which is not ionised. In the second the case is taken of an electrolyte where the electrical forces between the ions must be taken into account. In the third section, instead of using the expression for the potential energy in order to obtain the forces (as is done in Section 2) the electrical forces are used directly. T. B.

159. *A Mechanical Theory of Solutions.* **C. Dieterici.** (Ann. d. Physik, 72. 4. pp. 241–264, Aug. 21, 1923.)—In previous papers [see Abstracts 651 and 1548 (1923)] the author has shown that for the mole of every pure liquid, and also for that of every dissolved substance, there is a definite optical active volume, the refraction volume, which remains unchanged according to observations of refractive indices both for concentrated and extremely dilute solutions, *i.e.* this volume is at constant temperature independent of the internal pressure. The problem is now discussed of the significance of this volume, and the relation it bears to the mechanical mole volume. Van der Waals' equation for the internal pressure is first considered from the standpoint of the degree to which the magnitude b can be regarded as constant for every substance in the liquid state. Tables of data are given for water, ethyl alcohol, and ethyl ether, from which is deduced that for pressures of 1000 atm. the values of b for all 3 substances are constant, and at normal pressure the covolumes are only about a quarter of the visible volumes. It is a necessary consequence that the velocity of sound in liquids is given by $v\sqrt{RT/mK}/(v - b)$, so that knowing $K = C_p/C_v$, values of b can be alternatively determined. The calculated value for the cohesion pressure of water is appreciably smaller than that from the critical data, but alcohol and ether afford better agreement confirmation for the values of b is also afforded by compressibility observations, and data are given for NaCl and sugar solutions. A discussion then follows for mixtures of alcohol and water, after which the problem of temperature dependence is treated. It is concluded that although a connection between the optical refraction volume and the kinetic dimensions of the collision volume is not established with certainty, yet on mechanical grounds this is extremely probable. H. H. Ho.

160. *Resistance of Nickel Chrome Steel to Corrosion.* **R. Stumper.** (Rev. de Mét. 20. pp. 620–621, Sept., 1923).—Plates of a special nickel chrome steel 50 × 50 mm. were exposed to the action of hydrochloric acid, sulphuric acid, sodium chloride solutions, moist air, and tap water. The acids varied in strength from 1 % to 20 % and the salt from 1 % to 3 %. The time of exposure was from 40 hours to 7 days. The loss of weight was compared with the loss experienced by plates of the same size made from acid chrome steel. The nickel chrome steel contained silicon 0·54 %, phosphorus 0·012 %, manganese 0·65 %, carbon 0·6 %, chromium 15·68 %, nickel 7·04 %. It corroded to a very slight extent, the loss of weight being very small or nil in most cases, while the acid steel lost a considerable proportion of its weight. Expressing the loss of weight of the acid steel in 20 % hydrochloric acid for 7 hours as 100, the special steel lost 10·1, whereas in sulphuric acid of the same strength the acid steel lost 100, the special steel did not show any loss. F. J. B.

161. *Vapour Pressures of Concentrated Sucrose Solutions.* **E. P. Perman** and **H. L. Saunders.** (Faraday Soc., Trans. 19. pp. 112–116; Disc., 117, July, 1923.)—Results are given of direct measurements of the vapour pressures of concentrated sucrose solutions at 70° and 90°, the actual pressure of the vapour being balanced against a column of mercury. The relationships between vapour pressures and concentrations at these two temperatures are represented by smooth curves lying below the straight lines found by Perman and Price [Abstract 291 (1913)] as the result of measurements made by a dynamic method. According to Callendar's theory, which states that definite hydrates are formed in solution, the value 5 is indicated for a, the hydration factor, in the formula,

$$\frac{p'}{p} = \frac{N - an}{N - an + n}$$

where p and p' are the vapour pressures of the pure solvent and solution respectively; at the higher concentrations, however, the value of the hydration factor falls, apparently gradually, as no definite transition points are observable. Babo's law holds well for sucrose solutions up to the concentration 80 per cent. T. H. P.

162. *X-Ray Investigation of the Effect of Cold Rolling on Sheet Steel.* **Y. Niwa** and **J. Matûra.** (Electrot. Laborat. Tokyo, Japan, Researches, No. 122. pp. 1–20, Dec., 1922. In English.)—The authors have studied the effect of cold rolling and annealing on two steels containing 4 % Si with 0·14 % C, and 0·04 % Si with 0·11 % C. They find that in cold rolling the strain penetrates gradually from the surface of the metal into the interior and that the crystal grains are broken up into smaller cubic aggregations which tend to arrange themselves so that one edge of the cubic lattice or one diagonal of the face is parallel to the direction of rolling.

Effect of annealing.—Annealing the cold rolled material below 600° C. has no effect on the Laue figures. Between 700° C. and 800° C. change sets in and is completed at 1100° C. (Time of annealing, 2 hours.) J. L. H.

163. *Hardening of Metals.* **S. Kimura.** (Electrot. Laborat. Tokyo, Japan, Researches, No. 123. pp. 1–7, March, 1923. In English.)—The author discusses the theories of hardening due to Rosenhain, Jefferies and Archer and Honda, and concludes that the increase of slip interference (and therefore of hardness) in solid solutions must be explained by the interatomic stress caused by the distortion of the lattice. In addition the author considers the hardness produced, in steel and duralumin, by quenching. J. L. H.

164. *Chemical Constants of Diatomic Gases.* **J. R. Partington.** (Phil. Mag. 46. pp. 329–330, Aug., 1923.)—The expression obtained in a previous paper [see Abstract 389 (1923)] is $\log_e \frac{m^{5/2} r^2 2^{7/2} \pi^{7/2} k^{7/2}}{h^5}$. It is compared with the expression deduced by Sackur, which is considered to be in excess of the correct value for a molecule composed of two identical atoms by $\log_e 2$. A. B. C. L.

165. *Electrometric Titration of Iodate, Bromate, Chlorate and Ferricyanide with Titanous Sulphate.* **W. S. Hendrixson.** (Am. Chem. Soc., J. 45. pp. 2013–2017, Sept., 1923.)

166. *Superficial Tension and Voltaic Properties of Mercury.* **E. Perucca.** (Accad. Sci. Torino, Atti, 57. 14a. pp. 293–299, 1921–1922.)

—There is perfect parallelism between these, when the mercury surface is fresh; and as it changes under the influence of surrounding gases the parallelism is affected but the changes are analogous. A. D.

167. *Galvanic Cells with Atmospheric Oxygen as Depolariser.* **A. Nasarischwily.** (Zeits. Elektrochem. 29. pp. 320–323, July 1, 1923.)—Cells with direct and indirect atmospheric oxygen depolarisation are discussed. With the air carbon electrode the output per sq. dm. of active surface during regular working is at most 0·03 ampere, owing to the low velocity of reaction, whereas, under the same conditions, the cupric oxide electrode gives as much as 1·2 amperes per sq. dm. T. H. P.

168. *Electrolytic Estimation of Antimony.* **A. Lassieur.** (Comptes Rendus, 177. pp. 263–265, July 23, 1923.)—By suitable control of the p.d. between the electrodes, and particularly by the employment of a mercury-covered platinum kathode, a deposit of Sb is obtained of such properties and purity that quantitative results of much greater accuracy than hitherto available can be obtained. A. B. C. L.

169. *Investigation of the Anode Effect.* **K. Arndt and H. Probst.** (Zeits. Elektrochem. 29. pp. 323–334, July 1, 1923.)—Experiments were made upon the electrolysis of fused salts and the behaviour of the anode during electrolysis. It is observed that the anode becomes coated with a light foam, the evolution of gas sets in, and at the same time the bath voltage rises and the current diminishes. A slight hissing sound accompanies these phenomena. The anode behaviour in the case of calcium chloride, sodium, potassium, magnesium, strontium, zinc, tin, and lead chlorides and the effects of various makes of carbon anodes upon the behaviour. For details the original paper must be consulted. F. J. B.

170. *Effect of Slight Additions on the Electrical Conductivity of Solid Salts.* **C. Tubandt and H. Reinhold.** (Zeits. Elektrochem. 29. pp. 313–317, July 1, 1923.)—The results of experiments on the migration of ions in mixtures of lead chloride with silver chloride, or sodium chloride, or potassium chloride [see Abstract 770 (1920)] indicate that, in the increase of electrical conductivity produced in solid salts by the addition of other salts in small proportions, such additions have no immediate part; the action consists solely of increase in the mobility of the ions of the principal salt. The increased conductivity is not connected with the formation of solid solutions, and is manifested only when the two component salts are mutually immiscible in the solid state. Apparently the extraneous salt retards recrystallisation, and thus causes a finer granulation and a consequent increase in the lattice of the number of more loosely bound limiting ions of the separate crystals in the crystallites. T. H. P.

171. *Ionisation Produced by Hydration of Quinine Sulphate.* **(Miss) Chamié.** (Comptes Rendus, 177. pp. 181–184, July 16, 1923.)—The experiments previously described [Abstract 1271 (1923)] have been repeated under more exact conditions. The curve representing the diminution of the ionisation current, when the latter is in the neighbourhood of the saturation current, is symmetrical with that showing the increase in weight of quinine sulphate by hydration, the curves being referred to the same time-axis. T. H. P.

172. *Rotating Electrolytic Polarisation.* **Q. Majorana.** (Accad. Lincei, Atti, 32. i. pp. 499–504, May 6, 1923.)—In 1904, Christiansen (Ann. Chem. Phys. 8, vol. 1 (1904), p. 433) studied the elongation and fission of a globule of mercury immersed in a liquid electrolyte carrying an increasing steady current. The author has extended these experiments to rapidly alternating currents, and has found a remarkable series of rotations and fissions, which he considers in detail. A. D.

173. *Conductance of Dilute Aqueous Solutions of Hydrogen Chloride.* **H. C. Parker.** (Am. Chem. Soc., J. 45. pp. 2017–2033, Sept., 1923.)—Measurements have been made of the electrical conductivity at 25° of aqueous solutions of hydrochloric acid of concentrations between 0·04 and 3 millimols per litre, the solutions being made up by weight methods with an accuracy of a few hundredths per cent. with water with specific conductivity of the order $0 \cdot 1 \times 10^{-6}$. The values obtained for the equivalent conductivity exhibit a slight maximum in the neighbourhood of 0·1 millimols per litre owing to the influence of the impurities in the water, which apparently cause a somewhat greater effect than with iodic acid [see Kraus and Parker, Abstract 411 (1923)]. Comparison with the results of other investigators confirm the conclusions of Kraus and Parker regarding the considerable influence of the impurities in the water, and of the alkali in glass cells on the conductivity of dilute acid solutions.

Determination of the "cell constant" by intercomparison with three standard cells over a wide range of concentration with potassium chloride as electrolyte yields unusual results which may be explained by assuming the presence of an adsorbed layer (in contact with the electrodes) with a resistance greater or less than that of the body of the solution according as the electrolyte is negatively or positively adsorbed. On the supposition that hydrochloric acid is positively adsorbed and has consequently but slight correction for the effect of the adsorbed layer, a value for the "constant" is selected at the minimum point of the "cell constant" curve, which value is assumed to remain fixed in the measurements with the acid solutions. Extrapolation of the results on the assumption that the mass-action law is approached as a limiting form at infinite dilution gives the value 425·69 for Λ_0 for hydrochloric acid. On the assumption that the value of Λ_0 for the chloride ion at 25° is 75·8, the value 349·89 is obtained for the hydrogen ion at that temperature. By comparison of this with the value 349·93 found by Kraus and Parker for iodic acid, the value 349·89 ± 0·05 is deduced as the most probable for the hydrogen ion at 25°, the basis for the "cell constant" being more firmly established in the measurements with hydrochloric acid. The mass-action constant corresponding with this extrapolation has the value 0·105. T. H. P.

174. *Electrodiffusion.* **A. Gillet.** (Comptes Rendus, 177. pp. 261–263, July 23, 1923.)—A rectangular parallelopiped of jelly containing 10 % gelatine and 3 % Na_2SO_4 is subjected for a definite time to the action of 3·5 v. applied by means of two Pt-foil electrodes exactly fitting the ends of the block. The block is then sectioned and analysed, and a similar experiment is carried out in which the electrodes are replaced by jellies of composition corresponding to the layers adjacent to the electrodes at the end of the first experiment. The results are stated to show that the behaviour is as if the current were transported by the kation only, and as if electrodiffusion towards the anode involved complete molecular translation of the electrolyte. A. B. C. L.

175. *Electro-Endosmosis and Electrolytic Water Transport.* **H. Remy.** (Zeits. Elektrochem. 29. pp. 365–370, Aug. 1, 1923. Paper read before the Deut. Bunsen-Gesell., Hanover, May, 1923.)—When a diaphragm is placed perpendicularly to the direction of the current flowing through an aqueous electrolyte, transport of the liquid is effected both by electro-endosmose and by electrolytic transport of water forming a layer round the ions. With low ionic concentrations the electrolytic transport is usually negligible, but in more concentrated solutions this may be no longer the case. The results of measurements made with a number of normal and decinormal solutions show that the quantities of water carried in this way by alkali metal and ammonium ions are in the same order as those calculated from the mobilities of the ions. Hydrogen ions also carry a water-layer, but, if a layer of between 3 and 9 molecules for the water transported by the chlorine ion is taken as a basis for calculation, each hydrogen ion is associated with between 1 and 2 molecules of water. T. H. P.

176. *Intermittent Current Electrolysis. Part I. The Influence of Intermittent Current on Overvoltage.* **S. Glasstone.** (Chem. Soc., J. 123. pp. 1745–1750, July, 1923.)—The difference between the overvoltage values for a given metal obtained by the "direct" and the "commutator" method has been ascribed by some authors to the transfer resistance of a gas film situated at the surface of the electrode. On the other hand, some authors have questioned this view, and Dunnill attributes the low results obtained in the commutator method to the very rapid fall of potential that occurs when the polarising current is switched off. The present author points out that since the polarising current flows intermittently, the overvoltage will tend to be lower in the commutator method and also suggests the possibility of induced currents acting in the opposite direction to that of the polarising current. The object of the present work was to determine the effect of a perfectly unidirectional intermittent polarising current on the overvoltage at various electrodes as measured by the direct method. For this purpose a Tungar rectifier was used; this was supplied with alternating current from a 100-volt circuit, and was equivalent to a commutator giving 3600 breaks per minute. By the use of switches the electrode could be polarised with continuous or intermittent current as desired. A direct current of 0·15 ampere was applied for ten minutes. Measurements were then taken and the direct current was replaced immediately by the intermittent current. It was found that the effect of the intermittent current was to reduce the potential of the electrode. The difference in potential amounted frequently to 0·2 to 0·3 volt. The potential with intermittent currents varies much less with variation in the current than it does with direct current. The author concludes that the difference is partly due to the lowering of potential caused by alternating induced currents set up by the repeated make and break of the polarising current. W. R. C.

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